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BATTLE CREEK, MICH.
PUBLISHED BY THE AUTHOR.
1880.

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ERRATA.

Page 56, fourteenth and eighteenth lines from the top, should read Plate V., instead of Plate IV.

Page 68, third line in chapter heading, should read The Origin of Good Milking Families, instead of The Origin of Good Food Milking Families.

Page 121, twelfth line from the top, should read Jonas Webb, instead of James Webb.

PREFATORY STATEMENT.

ABOUT twenty years since, we discovered the origin of the YIELD MARK—escutcheon—on Milk Cows. But the excitement of the war and other matters incident to a farmer's life, such as changes of residence, and poor health, prevented any thorough consideration of the escutcheon mystery of Guenon till in 1868. In that year we explained the origin of the YIELD MARK to the late Hon. W. C. Flagg, of Moro, Illinois, who suggested a revision of Guenon's Treatise. But on looking more closely into it, we found nothing worth the labor of revision—only a fictitious system erected upon the *coincidence* of yield, with the size of the YIELD MARK as its sole foundation, which seemed to us quite insufficient to build a labored system upon. Instead of revising, we wrote a dozen chapters on different phases of the subject and its adjuncts, but finding other matters of value accumulating rapidly, we reduced the treatment of the YIELD MARK, and its relation to yield, to the two chapters specially devoted to it, adding a number of diagrams.

In 1868, soon after the reports of Doctors J. C. Dalton and W. H. Carmalt to the New York State Agricultural Society, on the subject of "Abortion in Cows," and "the negative results of the commission's investigation" were published, we carefully read their report, thereby discovering that the commission had entirely failed to recognize the material and very important fact, that with any considerable increase in a cow's milk yield, there must be a corresponding enlargement of the *Arteries* that convey blood to the milk glands. For over four years succeeding, we devoted much time and study to the various phases of the subject, the results being given in Book III. of this work, which several able physicians assure us is irrefutable; in which conclusion we cannot but concur. We refer to the text for full explanation, with the remark that the studies and labors which this subject required occupied about four years of time, nearly all the matter having been written over and condensed three times.

From a long list, we have selected about twenty other topics that seemed alike important and perplexing, giving such special study to them severally as our limited facilities permitted. Several of these problems have sufficient interest and practical importance to require a treatise for their full discussion and elucidation; hence, we have only been able to notice the more prominent bearings, from our own point of view, of course, of topics that a dozen short chapters are devoted to.

In discussing numerous questions of wide scope and bearing, views that conflict with current opinions and practices are advanced; for it is not to fall in with current views that we write, but rather, it is our purpose to state views and conclusions that seem to us more consistent and correct. In fact, to do any good in correcting anomalous practices, it is necessary to point out inconsistencies and fallacies, to the end that investigation and practical skill may devise methods of correcting practices that are found to be wrong or inconsistent.

This work, though in part fragmentary, is entirely original, and though our facilities for reference and consultation have been very limited, we have endeavored to advance only such conclusions, testing them occasionally by the best methods within our reach, as we hope will bear the ordeal of discussion, and the test of experience. Minor errors will of course be met with; but we hope and believe the views stated will be found, after due consideration, mainly correct. Apparent repetition will be met with, the object being to give various bearings of certain facts, and emphasis to views and principles that, if they are understood—as on the importance of exercise for *other* stock, as well as horses, for instance—there is little, if any, evidence of it, in practice, except in the distinguished case of *horses*. We believe a change in this matter is required, and our object is to promote the due use of the locomotive organs, and the lungs of animals that are now overmuch restricted in this respect, as shown in succeeding pages.

At our advanced age, faults of style are quite likely to be met with, from the fact that ill health has many times made rest, from days to weeks at a time, a necessity. But with persistent labor, we have endeavored to make the reasoning and meaning so clear that no one who takes time to think carefully* need be misled. Positive accuracy or perfection in statement or reasoning is out of the question, as if perfection were reached in any given direction, no further progress or improvement in that field would be practicable, so stagnation would ensue, which would not advance improvement, or progress.

The husk and kernel grow together, and though it becomes necessary to separate them, we cannot have either without producing both. The poorer in quality protects the richer in value. And we hope that if, in some parts of this work, rough bark or dry husks be met with, sound heart-wood and nutritive kernels in other parts will be

*Foster's Physiology is a good work to refer to.

found in sufficient quantity to repay the perusal of its pages.*

Whatever errors we may have fallen into, we hope to live long enough to correct or outgrow, even in our evening of life. So we present the work to our readers as it is, with the belief that many of them will, in due time, come to be of our way of thinking.

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*We are indebted for friendly hints and assistance on some points to a close thinker—Dr. D. C. Hawxhurst, Battle Creek, Mich.

INTRODUCTORY REFERENCES.

Breeders of Thoroughbred cattle will find matter for thought in chapters XI. and XII. on Crossing, and on Breeding power and Sterility; also in chapter VII. on Transmission by the cow; and in chapter IX. on Tenderness; and in several other chapters in which the sources of improvement in vigor and fertility are discussed. They will also find matter for thought in considering the sources of food value—chapters XXVII. and XXVIII.—in store cattle before they are fattened, the means of saving such value being made clear. Feeders of select grade cattle, and of show animals will find the explanation of the success of Mr. Gillette, the eminent feeder and successful prize-winner, of Logan Co., Ill., a topic of intimate interest—see chapters XVII. and XVIII.—particularly to those who have the noble ambition of producing the best quality of meat food by consistent and effective management. Breeders embarking in business on the western grazing grounds* will find practical suggestions on the surest basis of success in breeding, and on the sources of power of endurance, as the needed safeguard against loss from exposure, in chapters IX. and X., on Breeds of cattle for Western ranges, and

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*Just as we are going to press we read with gratification that Lord Dunmore is preparing to breed hardy Scotch cattle on an extensive ranch in Montana, which is consistent with the principles advocated in chapters X. and XIII. of this work.

on sources of Tenderness, and in other chapters. Also in chapter XIII., on the origin of character in *old* breeds of British cattle.

Farmers who feed common steers will ascertain by reference to chapter XVII., on loss of muscle and food value, why good steers, in a half-fat condition, fail in many cases to gain much in weight for weeks or months, when tied up and well fed. A source of great loss in food value, from the common practice of tying up to feed, is also explained in chapter XVIII. The subject of Crossing, chapter XI., presents facts that we believe may cause some surprise, particularly to those who resort to light-muscled sorts or families of cattle, with the expectation of improving value in the grades. Epicures will find the sources of gustatory enjoyment, or prime quality in meat, discussed, and in some degree explained, in chapter XVIII., on exercising cattle while fattening. Dealers in cattle, and those in search of good cows, will find points of practical interest, clearly stated in chapter VIII., on Selecting cows, and Handling qualities, and in parts of other essays.

Those who are firm in the belief that Guenon's *system* is valuable, will find the origin of the various marks described by him explained in detail, with a full and fair review of the subject in chapter II., on Guenon examined. While many other matters are treated, the consumers of meat may find hints and facts in chapters VIII. and XVIII., on feeding to maintain food value, and on loss of muscle and food value, and in the latter part of chapter VIII., on Handling qualities, of keen interest to them, some causes of variation in quality in different parts of the same animal, being stated.

Cheese factory patrons and private dairymen will find in the several chapters of Book III., topics of profound interest, discussed in a clear manner, by demonstrative reasoning, aided by illustrations; and in chapter XXX, on

Good Cows and their Training, in which the development of large yielding capacity is explained. The consequence of too much haste to grow rich, and of treating certain cows as machines, are not forgotten; it being also shown that Abortion, of the recent variety, is *not* epidemic, as the malady is clearly traceable to the mechanical influence of udder supply, artery engorgement, which itself is the result of over-rapid increase of artery blood, from too large supplies, or too rapid increase of feed.

Dairymen or others, who may desire to make the breeding of Milk cows a special pursuit, will find matter for thought in chapter VIII., on Transmission by the cow, and other suggestions with special reference to this subject, in chapter XXIX., on Alternate milking and breeding, and also in the several chapters of Book III.

Hog breeders and feeders, and those who keep cows for milk, in the vicinity of large cities, and elsewhere, may ascertain, in chapter XVI., how the breeding grounds of Bacteria are formed by preventing necessary exercise; and in chapter XVII., how millions' worth of food value are annually lost, in wasting the muscle-flesh and nutritive value of vast numbers of hogs and fattening cattle; also how to prevent Lung plague, and the inroads of Bacteria termo, souis, or other Scavenger organisms, or fungoid growths, in the chapters specially treating on these subjects. Owners of cows will find why many of the best milkers lose their Breeding power, either temporarily or permanently, by reading chapters XXVII. and XXVIII., and other parts of Book III., on farrow cows and deep milkers.

The development of several leading characteristics in well known Breeds of cattle is traced to its natural origin in chapter XIII., on old Breeds of cattle, while changes in the growth of Short-horn cattle, as observed in California, are several times alluded to, to show the influence of new external conditions, of soil, feed, and climate.

A number of topics that seemed to require it, are incidentally discussed* in different parts of the work; a special chapter being devoted to the results of fattening cattle at mature and immature ages—chapter XIV.— and to the necessity of bulk, in Air for breathing, and in feed for mechanical influence —see chapter XV.—as well as aliment. While the paramount influence of activity in developing muscle, power, and food value is shown by contrast and comparison, in chapter XIV., Book II., on Training, feeding and breeding, the subjects discussed being all named in the general Index of the work.

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*The loss from Abortion in cows was estimated at $4,800 000, years ago, in nine dairy counties in New York. In the other dairy States, together, the loss from Abortion is probably as great. But call the total loss from Abortion in cows $5,000,000 a year, with $3,000,000 a year loss in muscle and food value, and $2,000,000 a year more from loss of hogs by cholera, these items make $10,000,000 yearly loss, most of which can be avoided by preventive management, the nature of which is suggested in this work.

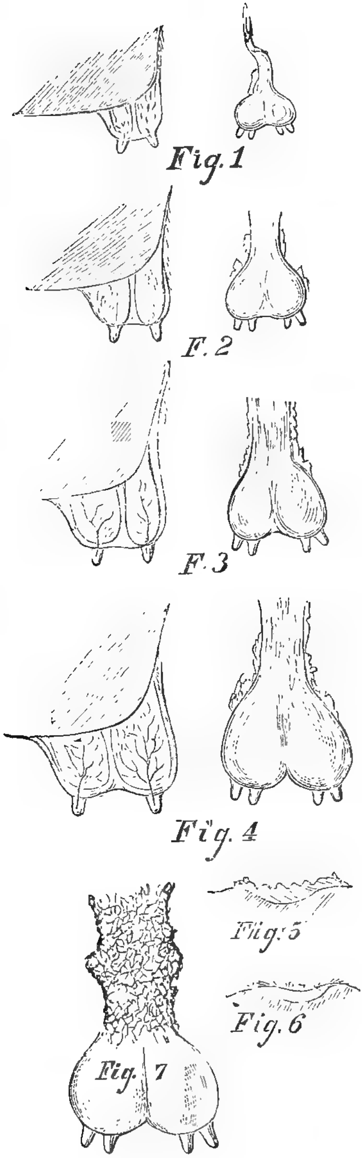

PLATE I.

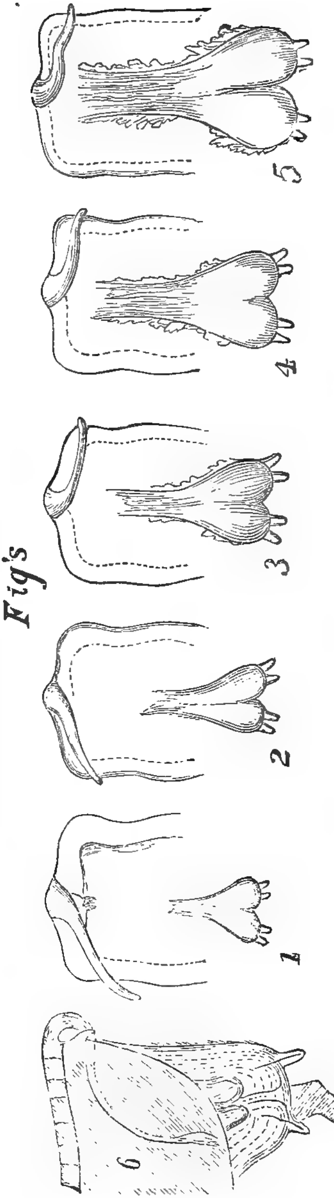

PLATE II.

CATTLE PROBLEMS EXPLAINED.

CHAPTER I.

History of Hand-milking and Udder-growth.

Udder Expansion Results from Storage of Yield.

In considering the large udders of Dairy cows at the present day, in comparison with the small bags of cows that are not hand-milked, but used only in connection with breeding, as a temporary reservoir for holding a few pints of milk for frequent suckling of the calf during its teething, we see a great contrast in size between the latter, and the large bags of good Dairy cows. The difference in size between hand-milked udders and udders that are not hand-milked is extensive—ranging from two to four or five times the small natural size—as shown in Plates I. and II. In Figs. 1 to 4, Plate I., the capacity of the udder is supposed to be doubled, according to size of udder shown, in the successive posterior views and sections, so that udder, Fig. 4, holds four times as much milk, when full, as the small bag, Fig. 1. And there are still larger sizes and differences between the small udders of cows that are not hand-milked and those that are kept specially to yield milk at the pail.

It is evident, then, that the great enlargement of the bag—the udders that have increased in size and capacity, in most instances since hand-milking began—is an effect, or incident, of the now very general practice of hand-milking itself. And, as hand-milked cows necessarily store and carry all the milk they make between successive milking-times, in their bags, it results that the udder becomes a reservoir or store-tank, in degree according to the average twelve hour or semi-daily yield of each dairy or domestic cow. So the extent of storage increases with the increase of milk formed by the udder glands; and the size, or storage capacity, of the bag is thus enlarged by enforced storage, the enforcement consisting in practically "stanking" the udder, or not allowing the milk to be drawn, either by hand of maid or man in the artificial way, nor in the natural way by the calf, at less than an average of twelve hour intervals.

There can be no doubt that "stanking" the udder, and making it a semi-daily store sack has greatly enlarged the bag of the cow; but it will not do to confound milk "formation"—from the artery blood—with the storing of it in the udder, *after* it is formed by cell action in the milk glands, for the production of milk depends upon the blood supply, and its natural basis, digestive power; which is a vital process; while storing milk is merely a mechanical process, or rather allowing a quantity of milk to accumulate in the udder, and keeping it there, for convenience, till the usual milking time; the quality of the milk being sometimes injured by retaining it in the udder too long.

An effect, in numbers of instances, of stanking the udder too long, and increasing its dimensions and storage capacity in that way, is a liability to overstrain the skin of the bag, and so repeatedly, till relaxation, or loss of contractibility, results; which some mistakenly approve, because it makes the skin thin and flexible, while it is really a permanent injury to the cow, in destroying contractibility in the part

The origin of storing, or stanking the udder, dates back to the first use of milk, in considerable quantities, by man; and this probably transpired in different localities and countries—as also happens in the use of oxen for labor—that led to familiarity with cow kine; and so milking cows in time became customary. It is also probable that sheep* and goats were hand-milked at an earlier period than cows, and that the use of the milk from the smaller, may have suggested its use from these larger animals. A thing so hidden by the lapse of time as the origin of hand-milking can never be accurately traced back to its beginnings. But it is certain that the hands of men or women became dextrous by practice, and that when it was seen that cows gave greater yields of milk, it naturally came to pass that the larger animals usually superseded the smaller in yielding tribute to satisfy the human appetite, so perfecting the art of its procurement.

Accidental stanking of the udder, as when the fatted calf was killed, may have suggested the relieving of cows' udders from humane motives. We can only conjecture as to motives or dates in this matter; but it is probable that tasting followed the drawing of milk, and—as of the origin of roasting suckling pigs, from tasting one that was accidentally scorched to crackling—milking, and the use of milk extended so far, and the practice spread so widely, and in so many countries, that there is not now the remotest probability of hand-milking becoming one of the lost arts. In fact, the very largely increased use of milk products, during the last twenty years, has led to an immense increase in dairying, and in the art of milking by hand; and if at first this appear trite or unimportant, the reverse will appear as we proceed; for:

*Since writing the above we find that sheep are now hand-milked on a large scale at Rochefort, France, where the blue-tinged Rochefort cheese is made. In the manufacture of this sheep-milk cheese, 300 women, besides numbers of men, are employed, the curing of the cheese occupying thirteen establishments in thirteen different caves, all containing *damp* air, the caves containing springs of water, which keep the air moist.

Storing milk in the udder—making that organ a reservoir to retain a twelve-hour accumulation twice a day—though incidental, is in fact a practical necessity, without which dairying, or even the use or sale of milk, on an extended scale, would not be practicable, as milking at intervals of one or two hours, or as frequently as calves empty udders by suckling, would involve too much labor and cost to admit of profit from the sale of milk, or dairy products. It is clear, then, that *infrequent* milking, and stanking or storing a twelve-hour yield in the udder at each time of its recurrence, is practically the basis of commercial dairying.

Though there is no increase of the actual daily yield—increase of milk depending upon increase of food digested, not upon accumulation of the product in the udder from stanking; nevertheless this practice has led to the very large increase in the size of the udder in dairy cows wherever it prevails, the enlargement of the bag being greatest and most conspicuous where improved dairying, and particularly cheese-factory dairying, is most extensively practiced. As a consequence of profit, greater care and more food has led to larger yield, and further increase of profit; and this serial process has been so widely and frequently repeated, that the small natural udder of two or three pints only has been gradually and successively enlarged by the expansive pressure of an increased quantity of milk in the glands, so that the small udders of multitudes of dairy cows have, by increase of milk yield, and its expansive force, been enlarged from the small sizes, 1 and 2, to the large sizes, 4 and 5, as shown in Plate II., and in the section at the left.

This increase in udder size is of course mechanical and artificial, being due to the expansive force extending from the central part towards the inner surface of the bag, which being formed of elastic muscles, gives way, and spreads out from the pressure of the milk. So the udder increases in size with the gradual or rapid increase of milk-yield, and its corresponding increase of expansive force, from, and as the direct consequence of, accumulating the semi-daily milk yield in the bag. This is so obvious that it would not have required remark, except to obviate misapprehension of the facts, which has been found more frequent than seemed probable.

But there is another force—a force that pervades the entire solar system—which of course includes both the cow and her udder, which has great influence in the enlargement of this milk reservoir; namely:

The *force of Gravitation* or the *weight* of the milk. The milk weight increases, of course, correspondingly with its bulk, or measure, and the pressure or strain of this weight on the bottom of the inner surface of the bag is increased directly in the proportion that yield of milk increases; and this weight force continues as long, and in the same proportion, as yield and its pressure are continued in the udder. The downward pressure and tension due to the presence of milk in the udder, and the influence of this tension and pressure by its weight are as constant, and evident, and certain as the presence of the milk itself, after it has been formed in the glands.

The regularly repeated downward tension on the bottom of the udder sack, is constantly tending to deepen the bag according to the amount and weight of milk; the downward pressure and its resulting tension on the skin that forms the bag, being increased correspondingly with the increase of yield. To the weight of milk, primarily, must be added the weight of the glands in which the milk is formed. The glands, with the lobes or quarters which inclose them, may weigh from a third to half as much as the weight of the milk itself. The gland weight is variable, but is included in, and makes up a large percentage of the downward pressure in the udder sack, being coequally constant with the tension of the milk-weight; the size, and weight pressure of the milk glands increasing with the quantity and weight-strain of yield, at all times. Thus, while the udders of milk cows that are making an increasing yield are being extended forward by expansive or centrifugal force, gravitation, or weight of milk, combined with gland weight, is as constantly increasing the depth or downward extension of the bag.

See Plate III., Figs. 3 and 5.

The relaxation of the udder sack becomes so conspicuous in large milkers, in some instances, as to make it evident that the combined influence of expansion and weight tension together have overborne the natural contractive force of the udder skin, thus permanently enlarging the bag by destroying, or, at least effectually suspending, its natural and necessary contractibility. This result is clearly shown in the uncontracting bags of cows that are dried only with great difficulty, and breed but seldom or fail to breed at all. The skin or sack of the udder is, of course, thinned down, as yield and size of bag increase, and this, when carried to excess or effected too rapidly, is doubtless the chief cause of loss of contractile power in the udder skin.

Increase of feed being the cause of increased yield, such feed as adds to the bulk of blood increases yield and the size of the udder together. Thus succulent feed, like grass and roots, tends to enlarge the yield and the bag, and in this will be found a reason for the largest milk-producing cows being generally found in the best natural grass localities, in both dry and humid climates. Thus the best grass countries in America do, or surely will with equal care and training, produce the largest or best yielding cows as a rule. The best natural grass districts of this country are in fact naturally our best dairy localities, and in these, accordingly, the largest yielding cows of permanent capacity will in a few years be found in the largest numbers.

The same rule applies to Europe, where the best dairy cows, at present known—by which are meant the largest producers of milk—are found in the humid climates of the coast country, both in west Scotland, and from Gascony in the south of France, along the low coast countries of north France, Belgium, Holland, Denmark and portions of Norway, and in humid localities farther inland. Grass is the natural food of the cow family, and where they consume the largest bulk of this succulent feed, there they will yield the most milk, and form the largest udders, with but few exceptions.

Humidity in the atmosphere adds much to the succulence of grass and permanency of pasturage, producing the largest milk-yield. The size of cows' udders, from the increase of yield, and its expansive force and weight-strain or gravitation, depend to a great extent on the abundance and succulency of their food; which again depends, at least in the growing season, on humidity of climate. Soiling and wetting feed, make but few exceptions to this general fact, on account of the attendant labor.

The cow is not by all believed the machine she is frequently alleged to be; but a living organism, with the power of changing food into blood, and organizing blood into milk, flesh, bone, and vital, living growth or tissue, according to exercise, breathing, and muscular power, upon which digestive power as the basis of milk yield, necessarily depends. When Newton saw an apple fall he found—that the apple fell downward in consequence of its weight-force or gravity; and it is no less true that, while expansive force enlarges the udder at its sides and forward, gravitation or the weight-force of yield also increases its depth and interior capacity.

CHAPTER II.

Guenon Examined.

Also his Illustrated Udder Forms, and other growths.

For the information of readers who may not have read Guenon's Treatise on the *escutcheon*—the heraldic name he gave to the Yield Mark, by which latter name it is uniformly designated in this work—we may briefly state that the writer of that essay, Francis Guenon, of Libourne, France, was the first writer, so far as we are informed, who published a description of the Yield Mark, by him called Escutcheon, by which is meant the upturned plate, or figure of reversed hair on the upper back udder, or twist, of nearly all cows that yield much milk. This mark, on good milk cows, is clearly visible, and may be seen plainly by any person. It is probable that many cow-keepers have noticed it, who have not read Guenon's Essay, nor any other description of this mark of yield. Guenon was very enthusiastic and persevering in examining cows. Between 1822 and 1828, he created *in his own mind*, "a system," or classification of the Yield Marks according to their size and form, on the twists of different cows.* He says, "A system was to be created, and I created it." In this, Guenon, like others that are more enthusiastic than reflective, took an erroneous course. There is nothing wrong in enthusiasm itself; on the contrary, it is an excellent stimulant. But Guenon's mistake consisted in endeavoring to

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* We have *two* copies of Guenon's Essay, one published by Thomas McElrath, N. Y., in 1863; the other by Orange Judd & Co., N. Y., 1867. So it appears the work was long ago translated, and pretty widely read in this country, causing much discussion.

establish a system without any other basis than the *coincidence* between yield and the YIELD MARK.

In his second chapter, Guenon says: "I divide cows into eight classes or families, and these classes each into eight orders. In each class I distinguish three different sizes, the high, the low, and the medium. This classification embraces all kinds of cows known to me." This is the substance of his classification. He attempts to explain and illustrate this illusive system by cuts of the YIELD MARK in the various classes and orders of cows he has created, ascribing important influences to accidental marks that have not the remotest connection with milk yield.

The number of classes and orders together is sixty-four. The eight classes are based on mere difference in *outline* forms of the YIELD MARKS, while each of the eight orders, in each class—sixty-four orders in all—is based on *different sizes and forms* of YIELD MARK, commencing with the largest size and numbering down to the smallest in each class; eight orders each in eight classes, makes sixty-four, multiplied by eight classes, gives two hundred and seventy-two divisions in Guenon's system. Call his classes sixty-four in number, and cutting off one-half of these—composed of cows yielding too little milk to pay for milking—and we have thirty-two classes or orders of marks and cows. Now as every one of these orders or classes blends or laps more or less, leaving no clear line of demarkation or distinction between them, what real ground is there for classification according to difference in size or form? Moreover, the same outline form of YIELD MARK is not inherited or reproduced in *any* case, as the influence of the male modifies the form of breech growth in the heifer calves, while the size of cows does not control the size of the mark, the size of the YIELD MARK being according to *weight* of yield, which probably averages more in proportion in cows of medium size than in large cows, in a majority of instances.

The capacity or size of the udder as a containing organ arises from storing the yield of milk. The *weight* of the milk yield presses down in the bottom of the udder, reversing the direction of the hair on the YIELD MARK by the force of weight strain, or gravitation, as demonstrated in the chapter on the origin of the YIELD MARK. Hence there is no ground whatever for classification, unless it can be founded on difference in *weight*, and the strain due to weight, in the udder.

The total size of the YIELD MARK varies with the weight and weight strain of yield, in cows of *any* size. There are exceptions to this rule, but the rule holds good in ninety per cent of all the best milk cows that we have met with in twenty years, which have been many thousands, in different States.

As to the variation in form of the YIELD MARK, there is variation in the form of every human hand and arm, from the variation in size, and arrangement of the underlying muscles, etc. There is also variation in the form and expression of the faces of cows, every one differing in some particular or degree from all others, so that every face constitutes a separate class, on the basis of slight difference in form. The outline breech figure of every cow varies from that of others as to width, hight, curvature, etc., which modifies the form of the thighs, and the surface of the breech growth, while the form of the *flesh* surface as to undulation under the skin *varies*, from difference in fullness of muscles, in every heifer and cow as naturally and as certainly as the forms of their faces. No two cows are precisely alike, though all have a general resemblance to one another. Hence a thousand cows will every one of them vary more or less in the flesh form which molds the skin, or surface covering of the twist, causing variation in the outline form of the YIELD MARK in different degrees according to the elevation or depression of the muscles over which its borders extend. So every cow makes a class, on the basis of slight variation in form, while all the cows in a State comprised but one class, on the basis of general resemblance.

The increase in the size of the YIELD MARK, and in that of the udder, is shown in Plates I. and II., the loosely attached skin of the twist on which the YIELD MARK extends being shown in the sections of the twist Figs. 5 and 6, Plate I. A section of the folds of the YIELD MARK, caused by weight strain, is seen in Fig. 5, same Plate. The sizes of the four udders above are successively doubled, showing the extension of the YIELD MARK higher and wider, and the extension of the udder lower and wider, according to increase of milk and its weight strain, the principle being more clearly illustrated in Plate III., Figs. 1, 2, and 4, which are designed to illustrate the influence of Gravitation in the udder and YIELD MARK, *not* the anatomy of the parts.

When Guenon failed to think of gravitation, he missed the mark, and gave—no demonstration as to his classification. We have shown that it has no natural foundation, and therefore no foundation at all, in the posterior growth of cows, the YIELD MARK itself standing securely and naturally as an Index of yield, and needing no other or further classification than its extension in size according to increase in yield; the increased strain, and its self-evident marks on the skin of the twist, arising from increased weight in the bottom of the udder, being as clear and certain as the influence of weight in a sack, or on a scale, or as the force of gravity in any other instance or situation.

But, while Guenon's classification or system building failed for want of foundation, or rather because it was a mere illusion of his fancy, he did two things of undeniable importance, publishing a description of the YIELD

MARK, thus calling the attention of others to the subject, and in pointing out the *coincidence* of yield, in nearly all good cows, with the size of the YIELD MARK.

Having described the process by which it is formed, and shown the nature of force that establishes the YIELD MARK, demonstrating its relation to yield, as an effect thereof, in special chapters on that subject, we pass on to consider a few of the various forms of YIELD MARK shown in Guenon's illustrations, for the convenience of readers who have read Guenon's treatise, who may find the subject, in its various bearings, further explained in Chap. V., on variations in form of YIELD MARK, and illustrated in YIELD MARKS and other figures of this work.

In referring to Guenon's illustrations we prefer to confine our remarks to the *second* best cows or orders in the classes of his cuts. We include two new classes shown in a chart * in which the new classes of YIELD MARKS are introduced, one of which, the *left* flanders, or class II., we shall now briefly consider, together with class 6, in Guenon's work marked VIII. in the Pennsylvania chart.

The peculiar fact about these two classes is, that in every instance in which the YIELD MARK is larger on one side than on the other, the larger part is on the *left* side of the twist; and in every instance in which it curves or diverges from a perpendicular direction, the divergence, bend, or curving is on the *left* side of the twist, and when the mark of weight-strain extends higher on one side than on the other, its extension is on the *left* side, even as high as the vulva, or root of the tail in several of Guenon's figures. The general form of the udder in these figures is correct; but the sharp points in the YIELD MARKS we have rarely met with. The YIELD MARK being due to weight-strain, should be as large on one side as the other, the yield

*Distributed with the Annual Report of Pennsylvania Board of Agriculture for 1878.

being nearly equal in both sides of the udder. The extent of the milk weight strain, of yield itself, is nearly equal in each side of the udder. Yet here, on the left side of the bag and Twist is seen clear evidence of greater strain on the *left* side than on the right-hand side, as shown in Guenon's cuts, and in Plate V., Figs. 4, 10, 11, and 12 of this work; and the evident fact is, that the extra size and hight of the YIELD MARK on the *left* side, is due to the extra strain which that side is subject to, twice a day, during the entire milking seasons of each year, from the extra force and pulling applied to the *left* side of the udder during, and by the process of hand milking. The extra strain on the *left* side, in drawing the udder towards the milker, is too evident to be denied,* so clear that it cannot be doubted. See Fig. 12, Plate V. of this work. Yet this mere difference in the form of its sides, from a cause that does not increase yield, is made the sole basis of Guenon's new second class of cows, and is the distinguishing feature of the sixth class in his system, or the eighth in his new classification.

The reader will not fail to distinguish the practical valu of the YIELD MARK as an always evident, naturally formed index of yield, from such illusory system building as that we have just explained or exposed.

We may now consider other marks to which Guenon alludes. In class 1 the ovals on the udder directly above the teats are simply the result of rudimentary teat growth,* which locks the skin to the glands, so preventing the drawing down of the root ends of the hair, thus certainly preventing its reversal; and the same is true of all the ovals directly above the teats in the other udder classes, and requires no further explanation.

In class 2, page 60, Guenon, the twist is very nar-

* See chapter on variations in Form, etc.

row, and the muscles of the thighs are very full—as we frequently see them in horses—the breech growth being nearly perpendicular, in which form the weight strain in the udder, particularly if the bag be set well forward draws the skin of the thighs close against the flesh, to which it grows, so preventing the reversal of the hair, except over the narrow space that is concave. But in this narrow concave, the skin is not drawn close to the flesh, hence the hair over the narrow concavity, in the best cows of this class, is reversed up to the vulva. The muscles immediately above the quarters of the bag are so full that weight strain does not extend much above the top of the udder, and the YIELD MARK is exceptionally small, because the thighs are almost vertical. Cows with a nearly perpendicular breech are only exceptionally or rarely met with, the thigh growth receding from the vulva down, in a very large majority.

In class 3 and 4, of Guenon, the muscles of the thighs and twist are full down to the top of the YIELD MARK; under this index of yield, the flesh surface recedes toward the junction of the milk glands. The fullness of the muscles above leads to the growth of the skin to the flesh, so preventing the reversal of the hair to any greater hight. And the same holds, as to class 4, in which, however, the flesh of the twist is full farther down, this fullness invading the top of the YIELD MARK and forming the crotch or forked form of mark shown on page 71 of Guenon, and in Fig. 4, Plate V., of this work. This forked form is exceptional, being seldom seen on cows. The 5th class of Guenon are small yielding cows, the weight of their yield averaging small, accordingly the YIELD MARK from weight strain does not extend far upwards. The sharp corners are very rarely seen on the twist. The same is also true of the 7th class; the concavity in the lower part of the twist narrowing to a blunt point. Over this concavity, the skin is loose, and a small YIELD MARK, corresponding with the weight and strain of yield, is formed by the weight strain in the udder, which reverses the natural direction of the hair, so forming the small sized Index to yield. The 8th class is too small in yield to require consideration.

Much has been said about bastard or spurious marks on cows, disparaging to the cows so marked, because they dry up early and rapidly. But so far from this being a spurious characteristic, it really indicates strong breeding power. Cows that dry up their yield early have strong breeding desire, or strong instinct; and they dry rapidly, because the necessary contractility of their Artery wall muscles is not weakened by relaxation, hence they are enabled to rapidly reduce the flow of breeding blood to the udder, thereby increasing the supply to the embryo, which is the cause of their drying their yield off early and rapidly, and of their breeding large calves, as they usually do. In fact they are the surest breeders among milk cows, because they devote their large amount of breeding blood to the breeding function during a longer period while they are pregnant. They yield as much milk as other cows, but they retain control of the blood which supplies the udder* because their arteries are not relaxed, and they dry up their yield by closing the udder supply arteries, and diverting the blood to the embryo, to sustain it, as is naturally required to enlarge its growth.

The yield of these imperfectly marked cows is large enough and heavy enough to form the outlines of large YIELD MARKS; but its weight in the udder does not continue long enough to reverse all the hair, hence some of it remains in streaks more or less unreversed. Another reason why portions of the hair remains "bristling" is, that the sudden shrinkage of the yield of bastard marked cows,

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*Read explanation in chapter on Cause of Abortion in Cows.

results from strong and well-balanced breeding power, and the diversion of the blood that supplied the udder to the placenta, or to the reserve of blood in the general circulation, in anticipation of the embryo demand, as shown by this shrinkage of yield occurring very soon after a new impregnation, or when breeding again commences.

The ovals of down-growing hair, sometimes, but very rarely, formed near the centre of the twist, may result either from the skin growing to the flesh, or from the inner and outer layers of the skin growing close together, either of which conditions prevents the root ends of the hair being drawn down, so preventing the reversal of the outside hair growth. These marks have no influence on yield, nor any signification in regard to it.

The patches of reversed hair on the buttock and hock bones, result from the great and much repeated tension on the root ends of the hair over these projecting bones, while cows or other cattle are lying down, the relation of these reversed patches of hair being to strain, but not to yield, in any way. Dandruff on parts of the udder that are but little exposed to rubbing, is the dead-cell matter that is constantly being discharged in all parts of the skin surface, and is pushed out into the hair by later discharges of similar dead-cell matter. The less any part of the skin is rubbed (or brushed, or combed) the greater the quantity of this dead-cell matter retained in the hair. The more actively the functions of the skin are performed, the greater the quantity of such dead-cell matter that is discharged from its surface.

The pale color of the udder results from the lesser proportion of its red blood circulation, in part; and partly from much of the udder or bag not being exposed to the tanning influence of the sun. The skin of the udder, in cows of large yield, is usually thin, the blood-vessels being small and thinly distributed, from the expansion of the udder to a large size, caused by storing much milk, which accounts for the moderate extent of circulation; while much of the udder surface is kept warm by the heat of the thighs, etc. Neither the dandruff, nor the pale color of the udder skin, has any influence or signification as to the quantity or quality of milk-yield; the blood supply of the skin, and its discharged matters being derived from the general circulation; while the MILK YIELD is formed from the breeding blood, which is conveyed in separate and special blood-vessels, that are adapted to supply the embryo during pregnancy, and the udder after coloring.*

Fineness in the hair and in the grain or fibrous structure of the skin and flesh, indicate thrift and good digestion, and the full completion of the various and successive changes in the contents of the cells during the process of assimilation; fine grained, compact and firm muscular structure, indicating much change in the crude ingredients of the blood during their transformation, by thorough assimilation into such structures as skin, hair and flesh. The same quality of structure probably holds true in the milk-gland muscles; all these structures being formed from the same quality of blood of the general circulation. But the quality of these structures does not indicate the quality of the milk, this calf food depending more on the quality of the cow's food than on any other conditions or circumstances affecting it.

The color of the skin may be yellowish from the oxidation of oily matter in the surface layer. But this does not affect the quality of the milk.

Having considered the various marks and conditions adverted to in Guenon's Treatise, including the trivial tufts, ovals, and rudimentary teat marks; the dandruff and the color of the udder, and the skin, as well as the more

*Read explanation on Breeding Arteries in chapter on Abortion.

important questions of size and form in the udder, and YIELD MARKS, we are compelled, in the absence of evidence to sustain his classification, to admit, and even to state, that his "system" is an illusion, for the reasons already given in detail.

Moreover, the evident practical value of the YIELD MARK could never have been even established by complicated assumption like that of Guenon, in which there is no rational explanation of the duration of yield, or the drying of the udder. There is not even a word of explanation in either of the editions of his work before referred to, of the origin of the escutcheon, correctly, YIELD MARK, nor in any way of its certain relation to yield; a very strange omission, which we have endeavored to correct, in the special chapter, demonstrating the origin of the YIELD MARK, or index, and its certain relation to both the weight and quantity of yield. The assumed or "created system" of Guenon, while not explaining any important fact, really clouded the subject in a fog of mystery, leading many to doubt, instead of convincing them.

Guenon is like the man who went a fishing and got a good bite; but his line, or hold on the fish, was not strong enough to draw the fish out of the water. So Guenon, while tugging away at it, really never saw the fish; never knew in fact whether it was a fish or something else; hence, he never examined it, understandingly; and consequently could not, and did not, explain what sort of a fish it was, or whether it was a fish or something else, that his line was too weak to draw out of the water.

We again give Guenon credit of discovering the *coincidence* between the size of the YIELD MARK and the quantity of yield. But while he only mystified the subject of the YIELD MARK by his "system" building, thus causing doubt concerning it; neither doubt on the one hand, nor mystification on the other hand, can further shake or obscure the fact or foundation of the YIELD MARK; for it results from the force of weight strain, and the law of gravitation, and will stand as the effect and index of yield, established by the milk weight, as long as the custom of storing milk in the udder, and the weight pressure of milk in the bottom of the bag shall continue.

The different sizes and forms of YIELD MARK are representative consequences of the difference in yield and its weight strain,* and in the outline figures and underlying flesh in the posterior parts, where the YIELD MARK is formed, on ninety per cent of all the best milk cows in Europe and America.

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*Difference in size in YIELD MARK on both same size and different sized of cows is shown in Plates I. and XI. and the variations in form are explained in chapter 5 on variations in form of YIELD MARKS.

Mr. Milton Mackie, of Massachusetts, informs us that cows that are worked, but not milked, at Emms, Germany, have only very small YIELD MARKS, or none at all, having no milk weight strain to produce the MARKS of YIELD.

CHAPTER III.

FORMATION AND COLOR OF MILK.

The Structure and Uses of the Udder.

The natural size and use of the udder are somewhat different from the artificial size and use, when it is not resorted to in the natural way by the suckling calf. The udder of cows in their natural state is quite small, holding but two or three pints of milk, for feeding the calf during the season—which is variable in length—of its teething; the custom of hand milking having grown up simultaneously with the domestication of cows, at various times, in different countries, and extending back through long periods. Naturally, the udder is a *breeding* organ, as it is necessary to maintain the calf till it is able to graze, or eat grass, and gather its own subsistence. To supply the calf with its natural sustenance during the period between its birth and the completion of its teeth, by hardening, is the natural purpose for which the udder is provided and used, and no other provision for completing the breeding process, and so maintaining the race, generally, appears; nor is it necessary; as the udder is quite effective as an organ for completing the process of breeding, or maintaining the breed, provided the cow obtains sufficient food. The cow consumes sufficient food, and forms from it a sufficient quantity of blood to supply the combined demands of both cow and progeny at the same time, or during pregnancy, as well as after calving; but the quantity of blood formed is widely *assumed* to exceed this combined demand; and the supposed excess is drawn by hand at the

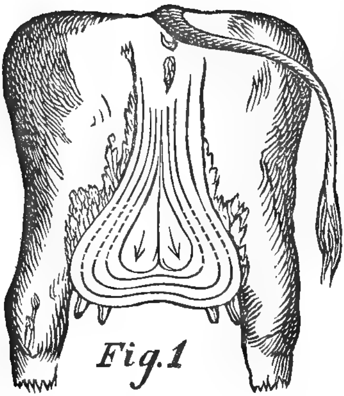

Fig. 1

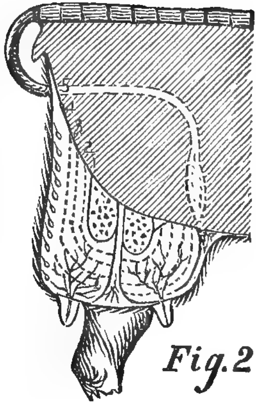

Fig. 2

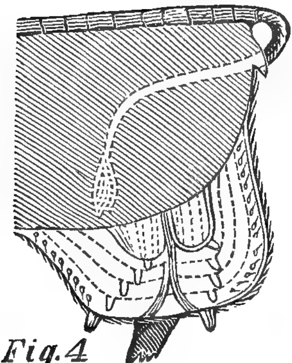

Fig. 4

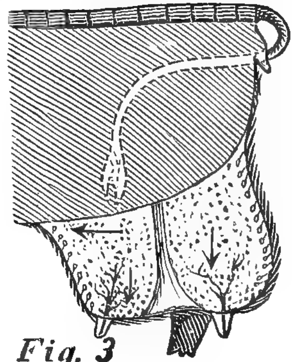

Fig. 3

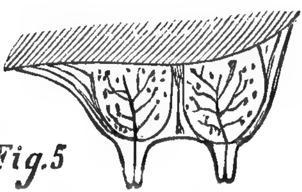

Fig. 5

PLATE III.

pail, when formed into milk, during the larger part of the Embryo breeding period.

To describe the exterior form of the udder would be difficult, because of the frequent changes in its size, and various degrees of its expansion. The udder skin or sack, is composed of several elastic layers which supply the contractive power of the skin, that enables the udder to expand when filling, by reason of its elasticity; and to contract or shrink as it is emptied, by reason of its contractility; the change in either direction, being made possible only by the elastic structure of the skin.

The interior of the udder consists of four quarters, each of which contains a large gland, or milk-forming organ, the gland and its enveloping fold forming a lobe in each of the four quarters of the udder. The quarters, though inclosed together, and loosely connected, are distinct and separate as to their blood supply and milk forming action; each gland having its special blood-vessels and blood supply. The upper parts of the quarters are attached to the walls of the pelvis and belly, being thus held up, or suspended by their muscular attachments at the top of the udder, and by which the udder is let down as its quarters are filled with milk; each quarter, or the whole udder, being drawn up by contraction, as each quarter, or the whole udder, may be emptied by suckling or milking. The glands of each quarter, or lobe, are in form similar to a cluster of grapes, with branching tubes instead of stems; the tubes having smaller branched extensions, as in the branches of trees, the smaller extensions terminating in follicles, which are small vessicles, or bags, with rounded ends. Each gland is inclosed in a fold or sheath. See rough outline in Plate III., Fig. 3. The cut may give a fair idea of the general form of a section through the center of a fore and hind quarter, forming one side, or half, of a large udder when full, two lobes or quarters being shown, to give an idea of the extent of the connection between the four quarters of the bag.* The large tubes, or channels in the teats result from the confluent junction of their numerous branches. See Fig. 5. The teat tubes are narrowed at their upper part, just below where the branches begin, by a muscular band which surrounds this part in each teat.

The cow instinctively contracts or relaxes this band, by which it is shortened or lengthened, thereby holding up or giving down her milk, by contracting or enlarging the channels through which it passes, according as her desire or instinct may influence her to do. The excitement of cows, when milking begins, causes them to contract these bands, but soon they slacken, and the milk flows out freely. If the milking be rapid, all the milk is obtained; but when milked slowly, many cows contract these bands again, being tired with relaxation, which is not, naturally, long continued, as the calf changes from one teat to another often; the relaxed condition also weakens the bands, if long continued. Slow milking makes much stripping necessary, and frequently is a cause of cows shrinking their yield. The quieter and quicker cows of any yield are milked the cleaner will their udders be drained, and the more milk will be obtained.

The chief reason of cows holding up their milk by the natural contractile power in the bands before noted is, that their instinct, or desire to suckle their progeny, is still strong, which causes them to hesitate—before freely giving down at the demand of a party to whom they have no natural ties. Affection for attendants may be developed by kindness and cultivation, but it can never become

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*In the summer of 1863 one of our cows had garget so severely in the hind quarter of the right side, that the gland suppurated, the disorganization extending through the fold of the lobe and skin to the quarter. An opening being thus formed, I pulled out the lobe, or gland, which was considerably decomposed. The opening healed, and the cow got well and continued to yield from the remaining three quarters.

as strong as that naturally extended to a cow's own progeny.

The size of the udder, or its capacity to contain milk, is, like that of the hind quarters, increased by the increase of its contents. The more food the cow digests the more blood she makes, and the larger the supply of blood flowing into the mammary arteries, and thence into the milk glands, to supply the ingredients of milk. By gradual or rapid increase of food, and of blood formed from it, the formation of milk and the size of the milk glands severally, and of the udder as a whole, have been *gradually* increased, as in Dutch or Netherland cows, or *rapidly* expanded, as in cows supplying American *cheese* factories; see Plate III., Figs. 2 and 4, and in the width of the back udder, and size of the YIELD MARK; see Fig. 1, same plate.

The formation of milk is a hidden vital process, so it cannot be precisely described, nor is this now necessary, as we perceive, by its results, as calf food, that milk contains the same kinds of nourishment that builds up the system of the cow, as in fact it must do, for milk and its qualities are derived from the cow's food, and vary as the quality of the cow's food varies.

It is evident, from the white color of milk, that the red corpuscles, or colored portion of the blood, does not enter the milk glands. The reason of this is that the oxygen of the blood passes into the cow's solid tissues, being withdrawn from the artery circulation for the purpose of structural change in the system of the cow herself, leaving but little of the oxygen of the blood in the udder supply arteries. This is the more probable because the calf colors its own blood, and supplies it with oxygen by its own breathing. Hence, there is apparently no occasion for oxygen of the blood in forming milk. The ingredients from which the milk is formed are, however, derived from nutritive elements of the artery blood, which are not taken up in nourishing the tissues of the cow. Chaveau says: "Milk is a white fluid having a sweet taste, and composed of an albuminous water containing caseine in solution, milk-sugar, salts, and fatty matter in globules,—the butter." This is doubtless a correct description.

The ingredients of the milk are not, it seems, secreted, or *strained* from the blood through membranes, but are produced by transformation of other substances into those composing the body of the liquid,—milk. Its liquid part, constituting a very large percentage of its bulk, consists chiefly of water containing albumen; its caseine is formed from blood fibrin; starch supplies the sugar of milk; while portions of the fats in milk are said, on high authority,* to be derived from proteids, or albuminous substances; and the butter globules, or *in* the globules—for probably the pellicle of the globule is albuminous—is said by Dr. Voelcker to "consist mainly of a mixture of several fats, among which palmatin, a solid cyrstallizable substance, is the most important. Palmatin, with a litte stearine, constitutes 68 per cent of pure butter. Mixed with these solid fats is about 30 per cent of oleine, a liquid fat, and two per cent of odoriferous oils." If the statement of Foster,† that fatty food is not favorable to the formation of milk—and he is well qualified to form a correct conclusion—be correct, some prevalent views will have to be discarded. We are inclined to think his view, that the fats in milk are formed from proteids, is correct; because the sugar and caseine of milk are produced by the transformation of other substances, and why should not the fat of milk, or certain parts of it, be also produced by transformation of other substances of the blood by solvent or cellular action in the gland follicles? It is certain that muscular substance is transformed into fat after it has be-

*Foster's Physiology. †See Foster's Physiology, p. 301.

come disorganized from inaction under close confinement, and this contains albuminous matter. But it hardly seems logical to suppose that such transformation would be required if the fats of milk were derived from the vegetable fats that are already formed and supplied in the feed. Other reasons why the very small proportion of fats in the feed—we have seen the proportion stated at $\frac{1}{500}$ part—would not seem to be sufficient or available to supply the fats of milk, consist in the fact that the vegetable fats are required for developing heat in all the tissues, which heat is set free in the tissues, and circulated in the blood; the vegetable fats in the feed contributing in this way to maintain the liquid condition of the blood, and its normal temperature, the circulation of the blood depending upon the maintenance of its temperature, which also prevents its coagulation.

The ripening of cheese results from the proteids being changed or transformed into fat, which at least shows that fat is formed, as Lawes and Gilbert, of England, proved in fattening pigs from substances which are *not* fat; and the formation of fat from other substances in the gland follicles, by a peculiar vital process, takes place within the fat-cells themselves. This process changes the proteids into fat, the fat being formed into cells, or globules, which multiply in number from the nutritive material of the artery blood. As they successively attain sufficient size, the fat globules separate, becoming detached *within* the gland follicles.

To whiten the milk, certain fat-cells—there are several kinds of fat—are emulsified by a juice secreted from the artery blood of the follicles, the fatty solution thus formed then mingling with the milk and whitening it. The butter globules are composed of yellowish fat, similarly formed, but of a different quality, and are *not* dissolved.

The fact of proteid substances being transformed into muscle when that is required, or into fat when not required to form muscle, shows why they are proteids, namely, to be available for different purposes. And it is certain that fats are necessary in milk to supply a source of necessary heat in the system of the calf, and in aiding to maintain the liquid state of its circulation, by maintaining the natural temperature of the blood, and so preventing its thickening and coagulation, which indicates the natural purpose of fats being formed in the udder to mingle with the milk. And the formation of fat in milk for such necessary uses is another proof of the wise and wonderful provisions of nature.

Milk partakes of the worst as well as the best qualities of the blood, and of the food, pure or impure, from which blood is formed; which is shown by fatal fevers having been traced to the use of milk of noxious quality; the dangerous quality, of course, being derived from the food or drink of the cows, accidentally obtained. Hence, pure blood is necessary to form wholesome milk; and the best quality of blood and milk can only be obtained from the best quality of food; the milk quality varying from good to bad, or worse than bad, as the quality of the feed varies from good to bad, even to dangerously bad; which strongly indicates that sound, wholesome milk can be formed only from sound and wholesome feed and water. Like cause, like consequence; impure quality in the food causes impure quality in the milk. Good, sweet grass—the qualities of *rank* manure sometimes are found in the grass it produces—either green or dried, is the standard milk-forming food; and its qualities should be borne in mind in providing substitutes, or other food, for cows. Milk, itself, after it is obtained, is a great absorber of taints, odors, and poisonous gases, wherever they come in contact with it; hence, for whatever purpose, it is safest to use milk when fresh, and, if it must be kept, to *preserve* it in pure air only; or keep it where it cannot be contaminated by contact with impurities of any sort.

The condition of the udder sack as to elasticity, is to a considerable extent an index of the condition of the udder supply arteries. If the udder has become flimsy and inelastic from over-strain and relaxation from excess of milk yield, the arteries supplying the milk glands are, in some cases, liable to certain degrees of over-strain and relaxation from the corresponding increase of blood. The milk glands themselves, as well as the udder skin, are liable to undue or over-rapid expansion, over-strain, and relaxation, from over-rapid increase in blood and milk, when yield is more rapidly augmented than the glands can be strengthened by nutrition in their various parts; or the skin of the udder can be thickened by nutrition from the general circulation. Uncontracting udders are difficult to dry, as dairymen are well aware; for this result—udder relaxation, and prolonged duration of yield—has long been a perplexing problem, while the failure of many cows, so affected, to breed, has equally perplexed their owners, as we have observed, in various localities and States; both points being specially considered in other chapters of this work.

CHAPTER IV.

Origin of the "Yield Mark"* Discovered.

Milk Weight Causes the "Escutcheon" Mark.

The word "Escutcheon," the Heraldic term employed by Guenon, and since by many other writers, indicates the subject of the present chapter, but not in any degree the method we adopt to clear the confusion of language and inference in which the subject has long been involved. The origin of the "Yield Mark" was an absolute "mystery" to Guenon, so much so that he has not once alluded to, or given the remotest hint upon the subject, in his work on the "Escutcheon." or, as it will be styled in this work, the "Yield Mark"—for the mark is certainly an effect of milk yield. Nor is there the least suggestion in any of Guenon's statements or conclusions,—and this we fear is true of Mayne, and other writers on this popular theme,—affording the least indication of the real cause and origin of the reversal, or upward growth of the hair, within the limits of the "Yield Mark," almost universally found upon the twist and contiguous thigh parts of cows of moderate or larger milk yield.

In the entire absence of light from any quarter on the causes or forces of which the "Yield Mark" is the necessary result, it devolves on the writer to make this explanation of the origin of this conspicuous "Yield Mark," in his own way, in accordance with his discovery of its origin, in 1861, and with the natural forces which produce it.

* This name being short and indicative, is constantly employed in this work, instead of the word "Escutcheon."

To facilitate explanation, a number of special illustrations become necessary, most of which, that are connected with this chapter, are grouped in Plate IV. Figure 2 is a section of the hind quarter, with half of the udder of a cow of small yield, and small-sized udder to correspond. The yield being small, the hair on the twist grows downward, as on the outside of the thighs, and the skin is closely attached to the flesh.

On the contrary, the hair on the back of the udder in the section, figure 1, turns upward, and the skin, or upper part of the udder sack, is only loosely attached to the flesh. In this figure—which may serve as a section through the central part of one side of the udder, about in the natural way—the udder is large; indeed, it is four or five sizes larger than the small or natural-sized udder, as shown in the small size, figure 1, in same cut, and in figure 2. As appears from the great disparity in size, the large udder may be capable of containing and yielding four gallons at the usual milking time, while the small-sized udder scarcely yields as many pints. The question is not yield, however, but the *cause* of the "Yield Mark," and, as the hair grows downward, and the skin clings closely to the flesh, in the small-uddered cow, while the upper part of the bag is separate from the flesh, and the hair grows *upward*, on the separated skin where there is evidently a large "Yield Mark" corresponding with the size of the udder, and the quantity of yield, which figure 1 may serve to indicate, approximately.

It seems best to trace this peculiar figure of *reversed* hair to its origin step by step, so as to comprehend it clearly and fully. If the outside part only, of the hair on the twist of large yielding cows were alone bent upward, there would be a sharp bend at the *surface* of the skin, as seen in Fig. 4. But the reversed hair is *not* so bent, but grows, all in the same lineal direction; the root ends, or part extending through the skin layers, and the outside growth or part of the hair, both growing in the same oblique direction; the root ends bending *downward*, and the outer ends or hair upward, as shown in the hind-quarter diagram, figure 5. This fact was established by four special dissections of pieces of skin, procured at different times and places, from the reversed hair figures, or YIELD MARK, with that special object in view *. The reversed hair was found to grow obliquely downward through its entire length into the cellular tissue, as shown in figure 5.

Fig. 3 is a section of the skin, in which it will be observed that the hair grows directly through it, and at about a right angle with the direction of the skin layers,† the outer growth of hair being most of it turned *downward*, in the coat of the cow, which results from the influence of air pressure, dews, weakness in the hair, etc. This shows the natural direction of so much of the hair as grows directly through the skin; that its direction is at nearly a right angle to the surface; and that the roots of the hair extend completely through all the skin layers into the cellular substance beneath the inner layer of the integument. Such is the direction of the hair, and position of its root ends, as it usually grows on the thighs, when the outside hair is not reversed or turned upward. In the same plate, Fig. 5, the layers of the skin of the back-udder are shown farther apart than is natural, which is to indicate the several layers distinctly. It appears, also, that the hair over the twist is not at first fully reversed; the process of its reversal being a gradual change from the natural direction, figure 3, to the fully reversed direction, in figure 6.

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*Sulphuric Acid much diluted with water, was employed, which in about three days dissolved the substance of the skin away from the hair roots, clearly exhibiting the direction of the hair root growth.

†There are diverse opinions as to whether the skin is formed of two or three layers. The illustration resorted to when this discovery was made, in 1861, may be seen in Johnson's Chemistry of Com. Life, Vol. II., Page 272, and in other works.

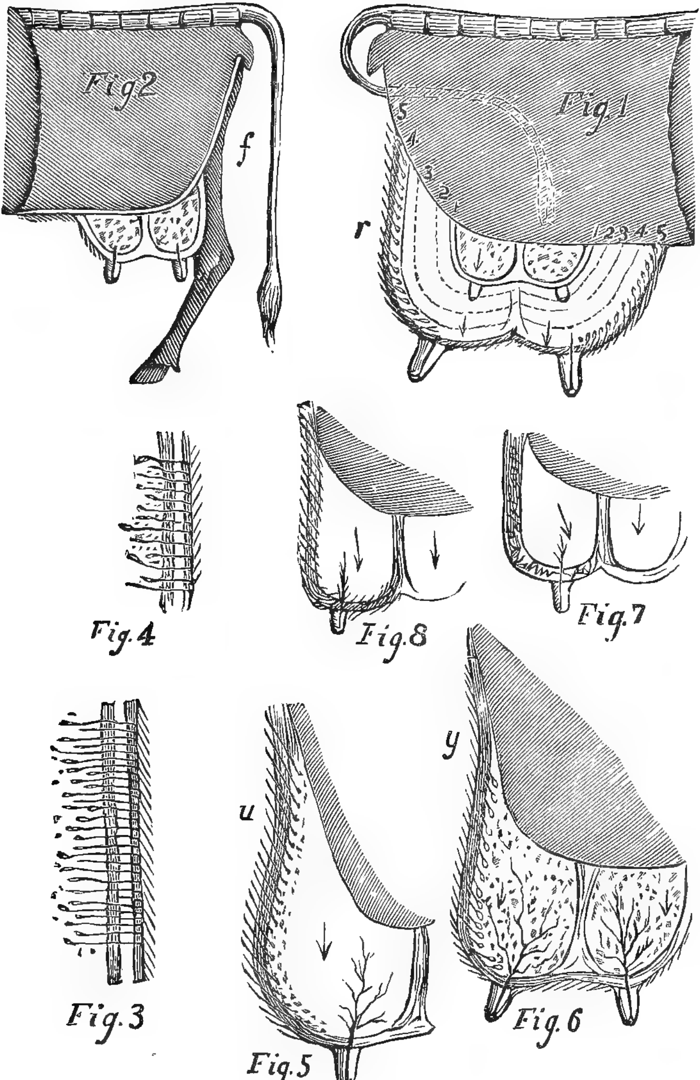

PLATE IV.

If three elastic sacks be suspended to receive flour or grain from the carriers above—the second and third being severally inside the other—the flour or grain will first press down on the bottom of the *inner* sack, or skin layer, secondly, on the bottom of the middle one, and lastly on the bottom of the outer sack, *alias* skin layer. This weight pressure being chiefly on the inner sack or layer, draws that layer down most and farthest; the middle layer is drawn down less, while the outer sack or layer is drawn down but little.

The weight of milk and glands together, the gland weight varying from one-third to half that of the milk, gives a weight pressure of 12 lbs. to each quarter of a four-gallon udder. Now assume the quarter, figure 5, to have this 12 lb. weight of a full gland in it, and that the outside layer is correspondingly fixed, and the evident effect is that the force of gravity, or the 12 lb. weight force in the direction of the arrow, presses down on the inner surface at the bottom of the bag, drawing down the inside skin layer first and most, the middle layer being pressed down secondly and less, while the outside layer (or sack,) being strained but little, serves as a fulcrum or fixed point in which the hair is fixed as on a pivot, and while its root ends are drawn down, its outside of hair growth is in this way turned upward. In this way the 12 lb. weight force bearing down on the bottom in each quarter, draws down the inner layer through which the hair roots extend, as shown in figure 5, so drawing down the root ends of the hair, and bringing the skin layers, Fig. 5, close together, as shown in figure 6, at the same time turning the outside growth of hair in an upward direction, as shown on the back udder in the same figure.

There would be no difference in this result whether the skin be formed of three layers as in figure 5, or two, with connective substance between, as in figure 7. From the pressure of the milk weight in the bottom of the udder, figure 7, forces the skin layers close together, as in figures 6 and 8, in this way drawing down the root ends and reversing, or turning the outside hair upward as in figures 6 and 8, and in the whole extent of the YIELD MARK on the upper back udder. In this simple way the YIELD MARK on milk cows is formed by pressure of the milk weight itself, in the bottom of the udder, by and according to the force of gravitation.*

The size of the YIELD MARK so formed, is larger or smaller according to the weight of the glands and yield together, as the quantity, weight, and weight tension of yield, the *size of udder*, of course, corresponding to the measure of its yield, and the size of the "YIELD MARK;" the necessary consequence of pressure or weight strain, corresponds to the extent of milk-weight, by and according to which this natural mark or Index of yield is formed.

In the manner described, the *force of gravitation*, or milk and gland weight, are combined, in drawing down the hair roots that extend through the inner skin layer, so reversing the natural direction of the hair on the loose skin of the twist, or *upper* part of the back udder, which indicates that the tension of the milk weight extends upward on the twist, and higher and wider on the thighs, according to the quantity of yield, and its weight strain.

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*In common window-blinds, the outer edges are turned up precisely to the same extent that the inner edges are turned downward, which illustrates the turning of the hair of the YIELD MARK upward by the drawing of the root ends downward. A very simple and effective illustration of the manner in which the YIELD MARK is formed can be made with six or nine narrow strips of pasteboard. Two or three of the shorter strips being fastened together with common hair pins, an inch apart, across the longer strips. The longer strips are half an inch apart, and may represent two or three skin layers, the shorter strips representing hairs. Now hold the rough model up vertically, or put it on the table, keeping one outside strip *fixed*, drawing the other outside strips down. This movement will bring down the inner ends of the cross strips, representing the root ends of the hair, as the long strips—skin layers are brought near or close together; the same movement turning up the outside ends of the strips, representing the hair; and showing the manner in which the hair is gradually reversed in forming the YIELD MARK on the upper back udder or twist of milk cows, in size according to their yield.

So the hight and width of the YIELD MARK, also, are generally according to the extent of milk weight pressure in the udder below, and to the tension on the skin of the twist above, the result being the formation of a YIELD MARK, in hight and width, according to the weight of milk, and the size of the udder, as roughly shown in Plates I. and II.

The corrugations or furrows in the skin, met with in *large Yield Marks*, that are formed by the weight strain of large yield, are also the result of great and continued strain on the skin of the twist, from the equally great pressure of milk weight in the bottom of the udder; the weight of the milk glands, of course, combining with the yield weight, according to natural gravitation.

Gravity, or weight force, pertains to all matter, whether in large masses or in small particles; or, compounded in a liquid form, as we find it in milk. The component ingredients of milk have as much weight after being mingled in the milk glands as before; hence, there is always downward pressure in the udder, in extent according to the quantity of milk in the glands, with corresponding *strain* on the inner skin layer and hair roots, in proportion to the weight pressing down in the bottom of the udder, so drawing down the root-ends of the hair, and forming the INDEX or YIELD MARK; which makes the demonstration of the origin of the YIELD MARK as a consequence of yield itself, sufficiently complete.

ENLARGEMENT OF THE YIELD MARK.

The YIELD MARK is usually transmitted by hand-milked cows, and is small in size, and would continue small on heifers, as it does in the bull, if heifers inheriting the mark were not hand-milked, but allowed to suckle their calves in the natural way. As soon, however, as milking at the pail begins, storing milk in the udder, for this purpose, also begins. With the storage of milk in the udder, milk-weight in the bottom of the udder begins to extend its strain higher and wider, in this way reversing the hair and enlarging the size of the YIELD MARK, during the heifer's first season of storing her milk in the udder. The size of the YIELD MARK is, of course, *increased* in this way as long as the quantity of milk and its weight-strain increase; the maximum yield of a season being reached, generally, before the first of August; after this time, yield gradually declines, but the YIELD MARK retains its size undiminished. During the several succeeding seasons, the yield increases till the heifers reach mature or full size, at five or six years of age; yield generally increasing, if feed be increased, enlarging the udder, the yield, and the size of the YIELD MARK correspondingly, as shown in Plates I. and II., and the *size* of this INDEX MARK is according to the weight and quantity of maximum yield, without regard to size or breed of cows.

THE PRACTICAL VALUE OF THE YIELD MARK

consists in its known relation to yield. It is established that the milk-weight originates the YIELD MARK, the yield thus establishing its own maximun Index by the strain or tension of its own weight or GRAVITATION. There is no myth about it, for it is so clearly evident that it cannot be disputed, nor reasonably denied.

The YIELD MARK indicates the maximum yield, which is an advantage, as, if the yield be small compared with the size of the MARK, it must have diminished, and measures can be taken to restore the yield to the full capacity of the cow, as shown by the YIELD MARK, which may indicate capacity for larger yield. The udder must have size according to its contents at any time, but its contents and size may be increased by stanking, or storing a days yield, or more—instead of only a twelve-hour supply—of milk in the bag at once; thus doubling its size, and making its distended appearance deceptive, and liable to mislead. But the size of the YIELD MARK cannot be increased suddenly in this, or any other way, for deceptive purposes, showing the advantage of its certainty. Much of the udder is frequently hidden, and it varies much in form, so that its capacity cannot be readily estimated, while the YIELD MARK is always conspicuous to view, and its size can be seen, which are further advantages.

The teats should, if practicable, be tried before purchasing a cow; but a view of the YIELD MARK saves the trouble of much handling, or inquiry as to the *quantity* of yield, for though the yield may be larger than the mark indicates, in exceptional cases, the mark from being produced by it, correctly represents the maximum yield of cows generally. Hence the size of the so-called milk vein—which simply represents a large flow of blood—the fullness of the arteries of the perineum, or even the fullness of the udder itself, are less certain, as indications of yield, than the YIELD MARK, as the YIELD MARK is an Index established by YIELD WEIGHT, and therefore a constant and certain Index of yield, according to the size of the Index mark.

CHAPTER V.

Variations in the Form of the Yield Mark.

They Result from Variations in Yield, and in Form of Breech Growth.

The variations in form of Yield Marks are very numerous, and some of them have been supposed to have, or to result from, some subtle or mysterious connection with yield; but difference in outline *form* of the mark has no influence on, or particular signification as to, quantity or quality of milk.

Gravity, or weight-force, pertains to all matter, whether in huge masses, or separated into atoms; or, compounded in a liquid form, as in water or milk. And the component elements of milk, have as much weight-force after as before, being mingled together in the milk glands. Hence, there is always downward pressure in the udder, according to the quantity of milk in its glands; with a strain on the root ends of the hair—as previously explained—in proportion to the weight of the milk and glands; the degree of weight being constantly proportioned to the size and weight of the full glands, whether these milk-forming organs be large, small, or of any intermediate size; or whether the cows be tall or low, or narrow or wide, in their breech form of growth. For instance: If the twist be widish, as is the case in many *low* cows, the loose, or upper part of the udder-skin will also be widish, as its attachments are made to the *firm* flesh of the thighs; *not* to the hollow or concave space between them. In tall, narrow cows, the breech is apt to be narrow; and so with the twist, or hollow space between the thighs; accordingly, the entire breech figure is narrower; the YIELD MARK, also, being narrower, and extending higher towards the vulva, in tall cows. This difference in width and hight of the breech-growth causes wider or narrower twists; which explains why YIELD MARKS, of regular outline, and about equal in their *total* size, so frequently vary in width and hight. For instance, in Plate I., the marks from 1 to 4 are shorter and somewhat wider than those on the taller figures, in proportion to hight of the cows and breech-figures—1 to 5, Plate II. The udder, also, is narrower and deeper, generally, in cows with narrow breech-growth; and wider, with less depth, in those of wider form; which accounts for the difference of width and hight of YIELD MARKS of the *same* or equal area of hair-surface; the same area of reversed hair being formed, generally, by the same extent of milk-weight, whatever the outline form of the YIELD MARK may be. Thus Fig. 4, Plate I., though wider and shorter, is of equal surface extent with Fig. 4, Plate II., which is narrower and higher; *regular* or usual outline forms being here considered. And as will appear, form and proportions of breech-figure growth have much influence in varying the outline *form*—but not on the total area, or size, of the *Index* of yield; or reversed hair mark.

The corrugations, or furrows, in the upper part of the bag, are apt to be deeper in tall cows, with deep udders, than in the same part of low cows; from the same degree of strain, from yield-weight; drawing down upon a narrower portion of twist-skin; the downward tension of the yield-weight, being the force, and cause, which furrows the YIELD MARK or loose skin of the twist. And, it is repeated, as important to remember, that the inner skin layer under the YIELD MARK is only loosely attached to the flesh, so as to move freely, as otherwise it could not be drawn downward by the weight-force of yield; as it evidently is, in forming the corrugations or furrows of the twist, in large yielding cows.

Two cross Sections of the twist, Plate I., Figs. 5 and 6, one showing smooth skin extending over the hollow twist space, the other the corrugated skin extending across a somewhat wider space, or twist hollow; the loose skin meeting that which grows close to the body; the junction or joining of the two, forming a crooked seam, or mane, as it may be called, of rough hair; some of it upright, and other portions leaning in several different and contrary directions. At these points—the seams, or marginal fringes of the YIELD MARK—the influence of weight-strain usually ceases, as appears from the hair beyond them growing in its natural direction. In this manner, the fringed, and more or less curved lines of rough hair enclosing the YIELD MARK, are formed, as the effect of the reversed hair meeting and mixing together with the hair that is *not* reversed; for the reason that the roots of the latter have *not* been drawn down by weight-strain, or any other force, out of their natural position and direction. So the fringed edges of the YIELD MARK on the upper back-udder skin, are the consequence of milk *weight-strain* extending to, and terminating at, the boundary lines between the body skin proper and that of the udder-sack, which is coated with reversed hair; the seams, fringes, and boundaries of various sizes of YIELD MARKS being roughly shown in Plates I. and II.

The generally close corespondence of *size* of udders with that of the YIELD MARKS, also appears in ten figures of the same Plates; the sizes of udder and YIELD MARK being duplicated in Plate I., Figs. 2, 3, 4, and increasing five-fold in Plate II., and its sections—Fig. 6.

These several combined results of enlarged udders and YIELD MARKS, result from the concurrent force of increased yield, and its weight-tension inside the udder sack; than which no fact is more clear and certain; while the influence of weight-strain is clear and very noticeably evident, in nearly all good cows.

The influence of yield and its weight-strain in increasing the size of the udder, and extending the hight, width, and surface area of the YIELD MARK, is shown in Plate III., Fig. 1, and its section, Fig. 2, and again in Fig. 4; five successive sizes of udder, and upward extensions of udder-sack being marked; while the Breech-figure view exhibits the extension of the YIELD MARK, or Index of Yield, as yield-weight strain extends it higher and wider, according to successive increase in yield and udder growth; and milk-weight, or gravitating weight-force, and tension in the udder. The reason why the hair of the YIELD MARK is distinctly reversed, as appears most conspicuously, when this Index of yield is large, is because the force of weight-strain in the bottom of the udder is greater, and longer in operation there than in any other parts of milk cows. And, while the weight-strain, or force of gravitation, has no influence on the quality of milk, the influence of tension, arising from weight of yield, extends farther upward and outward to the regular or irregular outlines, forming the limits of the YIELD MARK; reduced degrees of strain extending, in many cases, beyond, as shown in the various directions of the hair, inthe border shading of the mark; and on the variformed surfaces of the thighs, as roughly illustrated in the Figs.—Plates I. and IV. So the variations in the outline forms and boundaries of the YIELD MARK result from variations in form of breech-growth, and in the muscles of the thighs, under the mark; while the influence of the strain resulting from milk-weight in the udder extends as far as the skin of the thighs is loose, so turning the hair from its natural direction, the reversed hair, in fact, leaning back in the *opposite* direction to the strain, which draws on its root-ends; whether this, heretofore mysterious emblem of yield, be regular or irregular, or *lop-sided*, angular, or *winding* in its various outline forms; the form, of course, varying with different forms in the breech-growth of cows; or with the form of the mould, or muscles, underneath. Having used the term "lop-sided," it may here be explained by calling attention to the most evident and familiar of all the influences that affect the form of the YIELD MARK by *frequent strain;* the effect of which is shown conspicuously in the unequal-sided YIELD MARK in many large-uddered cows.

Viewed from a position behind the cow, the left side of the bag,—as seen most clearly in the left hind quarter—in many cows—see Figs. 10, 12, Plate IV.—hangs *lower* down than the opposite side. The YIELD MARK also, in such cases, usually extends higher up, reaching in some cases, higher than the vulva.—See Figs. 4, 10, 11, and 12, Plate IV.—while the border *shadings* where the strain diminishes—extend both wider and higher on the left, or chiefly on the left side of the udder and YIELD MARK.

As the increase in the depth of the udder is due to increase of gravitation; and this force is naturally the *same* on *either* side, we cannot ascribe increased depth in the left side, or left hind quarter, to increase of yield weight, primarily, on that side. Nor is it necessary that we should, for there is *much more strain* on the *farther or left side of the udder during the process of milking*, than on the right or nigh side; and the deepening of the left side—most conspicuous in the deeper hind quarter—is the effect of this supplementary pulling or handling-strain on the left, more than on the right side of the bag.

Furthermore, the increase in hight and width of the YIELD MARK, on the same left side is also the result of increased strain from hand-milking, and the forcible drawing over and stretching down of that side of the udder which

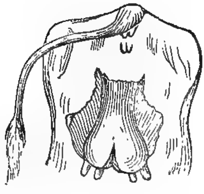
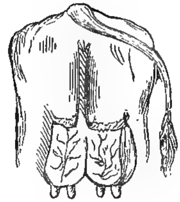


Fig. 1



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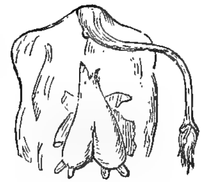

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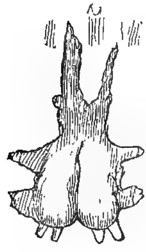
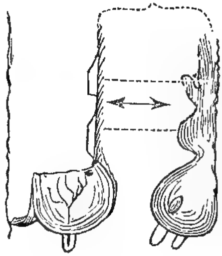


Fig. 4



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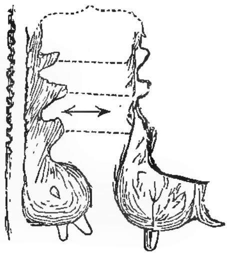


Fig. 6

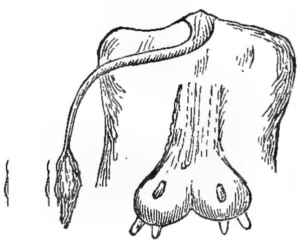
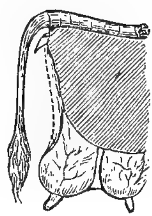


Fig. 7



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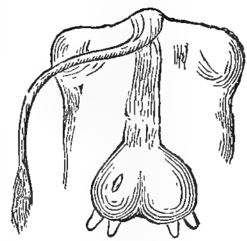


Fig. 9

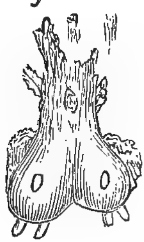
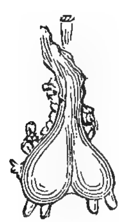


Fig. 10



11.

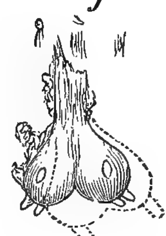


Fig. 12.

PLATE V.

is farthest from the milk-man,* which is the left side, as looked at from behind; and so the left side of the bag is stretched and deepened, and the left side of the YIELD MARK extended outward and upward, by the semi-daily repetition of this extra strain, that is inseparable from the hand-milking process. And so, too, the form and proportion of the YIELD MARK and udder are each changed to some extent, and the size of the left side is increased, as the inseparable effect of semi-daily tension on that side of the udder in stretching and drawing it over—see Fig. 12, Plate V.—to secure its contents in the pail; and this seems to be sufficiently conclusive, as to the influence of tension on the form of the udder, and the YIELD MARK. Hence it is unnecessary to add further proof, or suggest other instances of analogy on the influence of tension.

If the form of cows was generally uniform, the form of their breech figures would be equally so. But there are no two cows alike in the form, or in the expression of their faces, or in their general growth, which includes that of the breech parts. Accordingly, and consistently, there is as much variation in the hight, width, and details in form in the breech figures, as in the faces or other parts of cows. In fact the variations in form are as numerous as the cows in which they are found. And, while total *size* in the YIELD MARK increases with, and from, the increased weight of augmented yield, the outline forms and margins vary with the degrees of undulation, caused by variation in fullness and direction, etc., of the flesh or thigh-muscles under the skin. In some cases, fullness of muscles and extent of depressions, or lower parts of the flesh surface, is greater than in others; which is well shown by difference in the muscles of human arms. The differences in flesh surfaces as to elevated and lower parts, is similar in the breech

* "Milk-maid," German; "milk-man," American.

growth of horses, of which much is said; and of cows, of which little is thought.

The skin of the back-udder is drawn down in as nearly a perpendicular line as may be, by the weight of yield. And where the muscles are full, within the limits the strain extends to, the skin, when strained, fits close against prominent elevations, while it does *not* fit close to the hollow spaces. The close attachment of the skin to the fuller surface of the muscles, prevents, to a considerable extent, the reversal of the hair, so causing curved and irregular margins of the YIELD MARK. And as these forms vary in every cow, one from another, there can be no basis for classification on trivial difference in outline form of YIELD MARKS.

The extent of size in the YIELD MARK, without regard to form, in cows of any of the multitude of various forms and different sizes, is according to the maximum yield, and yield weight, whatever may be the size, or form, or breed of the cows on which the YIELD MARK is found.

CHAPTER VI.

Duration of Yield in Milk Cows.

Cows dry up their Yield to continue their Breeding Power.

Guenon, in his work on the "Escutcheon," has laid down fixed rules as to the time of drying, or duration of yield; but has not explained any point on the subject, nor established any basis for such rules. Hence the rules are merely simple statements. The mammary blood that supplies the milk glands at one season, and the embryo at another, is correctly the breeding blood, because it is specially provided to enable cows to nourish their progeny during the several stages of breeding. The mammary arteries are called by that name because they convey the breeding blood to the udder, which has teats for suckling. There are two sets of breeding arteries, both of which are provided for conveying nourishment to the progeny; but the breeding arteries are not naturally provided for nourishing the system of the cow.

The Ovarian and Uterine arteries are the mammary trunk tubes. One set of these arteries conveys blood to the embryo until calving time, while the other set comes into use at once, after calving—or a little while before—to supply the calf with milk, by supplying the udder with blood to form it. Only one set of breeding arteries is naturally in use at one time; as the demand for blood to nourish the embryo is arrested by calving, on the removal of the placenta and embryo together; the breeding blood which supplies the embryo through the placental circulation, previous to its birth and breathing, being conveyed in the udder supply arteries, thereafter, to form the milk for nourishing the same embryo, now a calf, at the udder. Naturally the udder is so small that it contains but half a gallon or so of milk at once, being emptied quite often by the calf, which sucks less, daily, *after* it begins to graze, the yield generally drying up as the calf begins to subsist by grazing; so that by the time the calf's teeth are quite hard—which varies—the cows generally dry themselves by gradually diverting the mammary blood to the embryo.

In four to eight weeks after calving, cows gain in condition, from having no calf to nourish, and come into heat, by reason of more blood, and blood-heat being conveyed to, and stimulating the ovaries, from which coupling again arises; and the embryo breeding stage again succeeds as before. This is the natural use of the breeding blood, the breeding arteries, and the udder. For, such are the natural means of supporting the calf by suckling at the udder, until it becomes self-supporting; hence the udder is a *breeding* organ, as a necessity to perpetuate the breed.

Commercially, and under artificial training, the course is so different, in several particulars, that it seems necessary to point out some of the variations from the natural way.

First: Instead of the udder being dried in a few weeks after calving, and the cow going naturally into heat from the influence of more blood and heat in the ovarian blood-vessels, her milk *increases* after the calf is taken away; and so small a quantity of blood is left, after supplying this increase of milk, that the ovarian region is but scantily supplied with blood, and coupling heat comes on quite *slowly*; so much so that cows of large yield, in a number of instances, fail to come into heat or to breed, as there is not a sufficient amount of blood heat in the region about the ovaries to fully mature the ova, and insure impregnation.

This is the probable reason why certain cows of large yield are shy breeders, or breed only intermittently, or in some cases, entirely fail to breed; the ovarian system being too scantily supplied with blood and heat, by reason of so large a proportion of the blood flowing to the udder instead of the ovaries. A majority of dairy cows do breed, however, though their calves are generally small, from insufficient nourishment, during their embryonic growth.

Soon after impregnation, the ovarian and uterine artery systems are again brought into use to supply the embryo calf with blood nourishment, through the umbilical cord and the placenta, or special breeding circulation, thus enabling cows to breed by supplying the blood naturally produced for this function. From this time forward there is a two-fold demand for the *same* blood, or a considerable and daily increasing proportion of it. Naturally it is required by the embryo calf in daily increasing quantity to form and enlarge its growth. Commercially, or for other reasons, it is demanded at the udder glands to supply the ingredients of milk. So, milking at the udder *retards* impregnation, leads to the breeding of *small* calves, and sets up a conflicting demand for the blood that alone can be spared after the system of the cow is replenished. On one hand this provision of blood for breeding, naturally is required by the embryo; on the other, it is demanded at the udder to form milk for domestic and commercial uses.

The embryo necessarily requires a daily *increasing* supply of blood, according to its increasing size, and to add thereto by accretion or growth, this increased demand and supply going on, the cow *feeling* the hunger of the embryo through their connected nerves, and supplying its demand, until the hunger be satisfied, and the process of feeling and satisfying, or rather endeavoring to satisfy the natural hunger of the progeny, is repeated and continued until calving time, when separation of the progeny from the cow takes place.

As the demand for blood nutriment is constantly increasing with the size and growth of the embryo, there must of course be a corresponding *reduction* in the amount of blood flowing in some other direction, to the udder, in this case—to enable the embryo to live and grow. And this reduction is the cause of the drying of the udder, in cows that are milked during pregnancy, as there is no other source—after the nourishment of the cow's system is provided for—from which blood nutriment can be increased, as the increasing demand, for the growth of the embryo, requires. It is necessary to remember that the consumption of food, power of digestion, and extent of blood production, are all naturally limited by the extent of blood nutrition required by the system of the cow individually, with that of her calf, as a natural supplement, added; but that the demand for supplying the udder and pail is not naturally provided for; certainly not during pregnancy, by any corresponding increase of digestive power.

If, *after* calving, and the weaning, or other disposition of the calf, hand milking is resorted to instead of calf-suckling, this is very different from the two-fold or three fold demand for the products of digestion during pregnancy; and without discussing its expediency, we simply point out the fact that hand-milking during pregnancy is in *conflict with breeding power* to the extent that it retards the rate and limits the degrees of embryo growth, by demanding the same blood—especially after the early months of pregnancy—that is required for nutrition, and growth in the embryo. That there is a conflicting demand is unquestionable; that it makes breeding by pregnant cows very inefficient, is also certain. That the usefulness of many cows is materially abridged for breeding, and their lives shortened by this conflict* of opposite demands, is equally clear and certain.

Naturally, cows must dry up their yield to enable them to breed. In breeding, they *originate* milk yield, and milk yield is necessary to complete the vital breeding process, while drying is necessary to *initiate* the preliminary breeding process; so that, though disregarded, breeding power seems too important to be entirely ignored even in dairy cows.

During embryo breeding the cow feels the hunger of the embryo through their united nerves, and supplies the demand which hunger indicates as long as the hunger continues, if possible. To do this she must control the flow of her breeding blood, through her nerve action, causing its conveyance to the embryo before calving, and to the udder after that event. This control by nerve influence, is exerted by means of contractile power in the udder supply arteries, which enables her to close these arteries during the embryo breeding process, thereby diverting the breeding blood to the udder after the calf is born. The evidences of this power are three: natural contractility in the artery walls, the fact of cows drying themselves by the use of this power in closing their udder supply arteries; and the other fact, that, without this necessary power, the supply of blood to the embryo, through the placental circulation, could not be increased, as it necessarily must be, according to increasing embryo size, and its corresponding demand for nutrition.

If this power of self-drying remained unimpaired, cows would naturally dry according to reduction of blood supply to the udder, to thereby supply the constantly increasing embryo demand, and the duration of yield would correspond with the period of drying.

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*See chapter on Alternate Breeding and Milking.

But numbers of cows do not retain control of their mammary artery blood, or retain the contractile power which is natural in these arteries, and this is the reason why many cows continue their yield, during a considerable period, while pregnant, some of them to near the full term of pregnancy, and others, as farrow cows, during two, and in some cases, three seasons in succession.

When cows hold up their milk by contracting the channels of their teats, this is an evidence of strong instinctive desire to nourish their young, and that the contractile power here exerted is strong. Naturally, contractility is required in the arteries; but in many cows contractile power in the arteries is much reduced by relaxation from engorging, degrees of increase in blood. In such cases, the udder skin is more or less thinned by increase of milk, and the bag becomes flimsy and uncontracting, which, though a favorite indication of yield, with some, is a certain evidence of weakened contractility in the udder skin, and correspondingly weakened contractile power in the udder supply arteries, or reduced power in the cows to dry up their yield. So instinct naturally controls duration of yield, which is reduced at about the same rate at which embryo growth increases.

The supply of blood to the milk glands is naturally reduced in advance of the actual demand by the embryo, because this is a necessity of breeding. But the length of time in which cows dry up their yield in advance differs with the strength of instinct, or contractile power under nerve control, the cows having the strongest contractility in their arteries and milk glands, drying as a rule, earlier than others of equal yield, that have weaker contractile power in the udder supply arteries, and also in the udder, in some cows.

It is probable that about half the best cows in the country—and particularly in Cheese Factory Districts—yielding over any average quantity of milk, are more or less *relaxed* in their arteries and udders, the milk glands being relaxed in many instances, from the same influence, namely, over-rapid expansion, the degrees of artery relaxation varying in different cows.

The yield of milk is generally according to the quantity of breeding blood—the supplementary blood that is added to the general circulation, but conveyed in the breeding arteries to the milk glands. The larger this supplemental quantity of breeding blood, the larger the milk glands and udder must be; and the larger the quantity and bulk of milk and the size of the udder, the longer the process of drying will require. The larger the quantity of blood from which yield is formed, the longer the time required for diverting it towards the embryo ; consequently the period occupied in drying up the yield . will be generally according to the quantity, and the duration of "yield" generally must be according to the size of the udder and the quantity of milk.

The dry feed of fall and winter rapidly reduces the bulk of yield in cows generally; and of course those yielding least dry first as a rule, because they have a smaller amount of breeding blood. The exceptions to this rule result from weak contractility in the udder supply arteries. Generally the rule will hold, on dry feed or green, that cows yielding the most milk will continue their yield the longest and latest. Remembering the exceptionally long duration of yield in cases where the arteries and udder are relaxed by engorging degrees ofincrease in food, blood, and yield, as explained in other chapters.

Duration of yield is generally according to its quantity, the size of the udder of course being according to the quantity of milk it contains. But as the prolongation of yield at the pail by pregnant cows is always in conflict with breeding power, it is not desirable, as a rule, after about the middle of pregnancy. It seemed necessary, however, to explain the reason of cows drying, and of the difference in duration of yield, in different cows. The "irrepressible conflict" between art and commerce, as against natural breeding power, will probably continue, the fear being that nature in the cow will be worsted in the struggle to survive, the too prevalent tendency being to feed and milk cows without regard to the conditions or limits of their digestive power.

The size of the udder is naturally changeable, and if it were not, it would be difficult to estimate its contents, as it is quite variable and irregular in form.

The YIELD MARK varies in form in different cows, with the outline of the breech figure, and underlying muscle growth of the parts it is formed upon, but its total size or area, *regardless* of *difference in form,* is generally proportioned to yield, because the mark is formed by the strain of the milk-weight itself, and must therefore be an index of the weight of the milk. So the relation between yield and the YIELD MARK is that of cause and effect, the YIELD MARK being the evident consequence of yield.

The YIELD MARK is, therefore, the certain and natural sign of maximum yield, and as the continuance of yield is according to quantity, duration of yield is generally according to the size of the YIELD MARK. The larger the yield, the longer the period of drying, by contraction of the udder supply arteries, and diversion of blood to supply the embryo demand.

It seldom happens that cows having a large YIELD MARK dry up rapidly or early. Hence a large YIELD MARK signifies *duration* as well as *quantity* of yield in proportion to the area of the index mark. A cow may inherit faint outlines of her dam's YIELD MARK. This would show only inherited capacity in her structure. But a clear, full YIELD

MARK is the result of maximum yield, by cows that are so Indexed. And, if the yield has shrunk, it can be restored to its previous maximum quantity, *in healthy cows,* by suitable feeding. The smaller the yield, the earlier embryo growth will dry up the cow; the larger the yield, the later it will hold out. Thus while reduction of yield represents increase of embryo growth, the *quantity* of yield and its *duration* are represented in the size of the YIELD MARK, in a large majority of cows.

CHAPTER VII.

THE "YIELD MARK" TRANSMITTED BY THE COW.

The Origin of Good Food Milking Families.

Generally, it appears to be the opinion that inheritance is more affected by male than by female power or influence, but probably this opinion is not well founded. This view may have arisen from so few male progenitors, compared to the number of cows, being employed; and that male marks and forms are therefore transmitted in manifold more instances than is practicable as to cow forms, or their YIELD MARKS. But the number of instances of transmission does not affect the question of prepotency in the cow or bull; as the general and vital organs and parts, pertaining to consumption, digestion, assimilation, nutrition, and locomotion, are possessed alike by male and female cattle. So, in considering certain influences of transmissive power, it is important to remember the distinction between growth that is indispensable to life, and merely incidental growth or marks that may be dispensed with without endangering existence.

That calves, male as well as female, inherit from the cow, in a large degree, is certain. If a bull calf from a cow of large yield have large *hind* quarters, for instance, this peculiarity will usually be found to have been derived from the cow, even if indirectly, through several generations; for large hind quarters usually originate in the acquired capacity of cows that yield much milk, from long previous training, combined in some cases, perhaps, with inherited growth of similar origin. But this form of growth is acquired only, and is not vital or natural. Nor is it even acquired by the male. Nor does it appear that a bull can transmit large size—except from ancestral influence, in a part in which he is usually smaller than the cow.

Yielding milk by *pregnant* cows is an acquired habit; and the power to transmit a tendency to yield largely, must have been previously inherited from the cow, where it originates. This holds as to large hind quarters; the *large* milk-forming power, and the enlarged part of the udder growth, which might be dispensed with—as is the case, to a considerable extent, in cattle that roam promiscuously on the wide ranges of Texas and South America—without danger to life. This is true of all the peculiar characteristics of artificial or acquired capacity to store milk; the natural capacity to yield milk, or form it, *not* here being under consideration.

Naturally, digestive power provides the blood, which is the basis of milk yield; but large hind quarters and large udders result, mainly, from milking cows that are breeding, which induces a larger flow of blood into the mammary arteries, both sets of which are located within the hind quarters.

Bulls descended from cows that have never been hand-milked transmit the vital parts—the muscles, nerves and bones—as readily as those descended from cows of large yield. But the original power to transmit *peculiar* growth, or acquired forms, resulting from large milk-yield or storage, primarily, is with the cow; hence the YIELD MARK must be inherited by the bull before he can transmit it in any degree; and the bull's power to transmit must be much weaker than that of cows, from being indirectly derived; and secondary as to time of origin.

These facts were not understood by Guenon, and seem to have escaped the notice of his copyists, none of whom, that we are aware of, have stated the distinction between growths that result from *special training*, and growth that is vital, and indispensable to the existence of milk cows.

The YIELD MARKS of bulls are necessarily inherited from the cow, whatever their extent; the male being exempted from all influences incident to storing milk. Hence bulls cannot be supposed to exhibit evidences of such influences, otherwise than by inheritance, of signs or marks, derived from cows. And a fact, apparently well established, that gives force to this evident truth, is, that the reversed hair marks of bulls do *not* increase in size after the animal is full grown; manifestly because the bull is entirely exempted from influences that mark the cow. When bulls inherit the marks from strongly marked cows, they are a consequence of growth in the underlying parts they are formed upon; but not of any vital or organic influence, at any time during general growth.

At maturity the mark on the bull is comparatively small; much smaller than in well-trained cows of equal size and age; showing that the causes producing the marks, operate on cows during the usual increase in their "milk-yield." The stationary size of the inherited marks in bulls after the age of maturity, is strongly in contrast with the self-evident increase of the YIELD MARK, in size, according to increase of yield, in many cows, until maximum yield is made. And here, contrary to our rule, we briefly quote some remarks bearing on this part of the subject. Mr. C. Sharpless, of Philadelphia, amongst others, writing on the YIELD MARKS of cows, says,* in effect: "It is important that the dam of a bull be unexceptionable in her udder and YIELD MARK, as her qualities, *inherited* by her son, will be *transmitted;*" admitting, as before explained, that the influence of the cow† is pri-

*See *Country Gentleman*, Oct. 26, 1871.

†Dr. Lucas, after weighing the whole evidence, comes to the conclusion that every peculiarity, according to the sex in which it first appears, tends to be transmitted in a greater or lesser degree by that sex.—Darwin's An. Un. Domes. Vol. II, p. 93.

mary and permanent; that of the bull being derived and subordinate. In another part of his remarks, the same writer says: "In young bulls the YIELD MARK is distinctly seen at any time after one month old, and is *precisely the same* that it will be when the animal is mature." If this means that the YIELD MARK remains the same in outline form, it is correct; and if it also means that the size of the milk mark, on the bull, is not increased after the age of maturity, it is again correct, as no influence tending to increase or affect the marks of the bull arises; while the marks of cows continue to increase in size until maturity, and even after, *usually, as long as yield increases*, which, in some instances, is long after the completion of their general growth.

In numbers of instances the marks on the bull are but very slight, and become less perceptible, or nearly disappear, by the age of maturity; in such cases organic growth obliterates the faintly inherited marks. The reversed hair mark on the bull does not, then, increase in size, after mature general growth is complete.

It is established then: 1st. That the YIELD MARKS originate in the cow. 2d. That it is an effect of milk-yield, or its weight-tension.

It follows that the YIELD MARK increases, or remains stationary in size, according to the increased or stationary strain and pressure of milk weight in the udder, and that the same influences that can increase its size must have originated the YIELD MARK in milk cows.

Acquired marks can be transmitted by either sire or dam; but prepotency, or superior transmissive power, as to the YIELD MARK, must be with the cow: 1st, because the mark originates in her own organism. 2d, for the reason that it enlarges with, and in proportion to, increase of yield; and 3d, and particularly, from the cows' being *per-*

manently subject to the influences* which produce the YIELD MARK.

Long continuance, of course, tends to fix forms or marks that are acquired; for this reason the YIELD MARK becomes a fixed mark, co-extensively with yield; as the same force, in kind, which originates the mark, continues to maintain this characteristic index of yield; thus giving the stronger power of transmission to the cow, as to marks originating from milk yield.

Furthermore, the "yield index, or mark," being derived from a given cow, is not reproduced when transmitted by male influence, until one or two generations *later* than when transmitted by the cow directly; or by cows of the same age, to their calves of the first generation. And this is true of other parts, such as large hind quarters, that are favorable to yield, or a necessary condition of the tendency to yield abundantly.

Cows can only mark one calf in a season, while bulls transmit such faint marks as they possess; the male having the advantage in giving his own markings as to numbers of calves. So it is rapid propagation, as to numbers, not superior power of transmission, which is the chief reason why the marks of bulls have so much importance attached to them by some writers on breeding.

It also seems highly probable that cow calves are more likely to inherit the growths and marks incident to acquired milking capacity, from their milk-forming structure being similar to that of the cow, and so being naturally formed and adapted to receive impressions or be affected by influences that contribute to establish milking capacity.

The distinction betweeen marks or passive signs of yield and active capacity itself should not be forgotten as capacity depends upon food, exercise, digestion and secre-

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*See "Origin of Yield Mark," &c.

tion, some of which may be suspended, or withheld, while the YIELD MARK remains the same—a sign of maximum yield; and by which it may be known whether yield has been reduced or not.

It might be surmised that, to enable the sire to transmit the rudiments of the entire organism, he must possess the forms complete in his own body, as he cannot transmit what he does not possess. So the primary forms of the vital parts are probably transmitted by the male. But growths, resulting from large milk-yield, *originate* in the cow, and are not to be expected in male calves, except as inherited *secondary* marks of slight extent and significance.

If rudimentary teats—which imply rudimentary udder growth also—be found in male calves, in such cases they are originally transmitted by the cow. But it is a question for naturalists to decide, whether rudimentary growths, required for milk-yield *only*, are not transmitted by cows to heifer calves, the cow probably marking male calves by reason of her prepotency, as to milking organs and marks. To us it appears that growths such as the YIELD MARKS, that result from the artificial custom of storing considerable *weight* of milk in the udders of hand-milked cows, must always be *peculiar* to cows *originally*, and only formed on the bull by accidental and secondary inheritance; the transmissive power of the cow being superior, as to marks arising from the acquired use of her peculiar organ, the udder.

If, in milking families of cows, their form is adapted to supply large yield, the usual form of the bull cannot be so adapted, as to large hind-quarter growth, except in very rare instances. For this reason more importance is sometimes attached to procuring bulls from milking families than to more important points of form in the growth of the *cows* that are to digest the food and produce the blood which supplies the ingredients for forming large yield. When suitable form of growth is found in cows, with good digestive power, large yield can be obtained by special training; but when suitable forms of growth do *not* exist in cows, neither blood relationship with milking families, nor even good training of *aged* cows, can supply the deficiency.

Of course, good milk cows have suitable forms, and their influence should not be counteracted by adverse forms in bulls; while good form in the organs and parts specially concerned in large yield, in the cows themselves, is of the first importance; and these forms, being acquired by the cow originally, are transmitted directly by her with certainty.

Origin of Milking Families.

It will *not* avail to depend on inheritance, from *either* side or sex too much, as large milking capacity is developed and established by practical training—together with suitable supplies of food—by careful men and good managers; who in this way *originate* "milking families," with very limited appliances and at little cost, in many instances and localities.

It is a prevalent custom with many small farmers—who are the *best* practical calf raisers—for example, to select heifers with good natural form and capacity for their size, to begin with, and continue their selections in the *female* line; this being continued from two to three, or in some instances, half-a-dozen generations, in scores of localities. In this way it is that "milking families" are formed by persevering care and training, and established by repeated selection and *direct* inheritance. The popular preference is, however, restricted from necessity; and considering this fact, the success in establishing "milking families," in many places, is remarkable.

In some instances there is a preference from mere fancy, without definite ideas, unconsciously entertained; but from whatever cause or motive preference originates, or whatever the breed or descent, it is a necessary fact that superior milking capacity is originally developed in cows by special feeding and superior care, treatment, and training. And the prevalent preference of dairymen generally for selected native cows, is a well-grounded and significant recognition of the influence of good *training* in developing capacity, and the YIELD MARK, which is the index of capacity. The influence of the bull contributes to natural or vital capacity, while in-breeding tends to establish uniform color and the peculiar external markings of the breed. But extra cows, from select families of common stock, have the advantage of having their capacity established by the personal care and supervision of their owners, which is the source of their superiority, and of success in establishing "milking families" of common cows.

BOOK TWO.

CHAPTER VIII.

Selecting Milk Cows.

Handling Qualities, and Quality in Cattle Products.

Almost every one who buys or keeps cows, has his individual taste or fancy to satisfy, without much regard to questions of economy or practical value. Still the calculating faculty, and the desire to know the reason why, are more active in our day than at any previous time. There is as much difference in the fancy of writers and in the preferences of merely practical men, as in others who buy cows. Practical men themselves are sometimes quite impracticable, when drawn out of their immediate sphere; one of their peculiarities being that they know certain things from experience only, without being able to explain the reason why, in some instances.

The wedge-shaped cow is frequently recommended as the best for milk; and if mere bulk of milk be the object, this form is adapted to large yield. Wedge-shaped cows may be good cheese cows; but as this is not a well-balanced form, the cows are likely to be inactive; and the quality of their milk thin. Cows that are wedge-shaped, have, as a rule, according to the law of compensation, lost as much size in their fore quarters as they have gained in their hind quarters; hence, while large hind quarters provide for a large supply of blood in the vicinity of the udder, the accompanying small fore quarters indicate reduced digestive power and less bodily vigor. So the wedge shape is not suitable for vigor and activity, and endurance. Still, the wedge-shaped cow is suitable for cheese, or bulk of milk.

The cow for Butter need not have large hind quarters, as the quantity of butter depends upon the quality of milk rather than its quantity. For butter, however, in cows of any form, breed, or size, the cow should be good natured, and have a mellow and rather oily skin, with fine soft hair, and gentleness of disposition; the latter being indicated by a pleasant countenance, of mild expression, the expression of the eyes being mild, as a leading feature.*

For general domestic or family use, we would not choose a narrow-formed, long-faced cow, as such are not usually good tempered; while they are frequently flat-sided, with weak muscles, and loose jointed, with little vigor, not being economical to keep. The form of cow—or steer—for vigor, thrift, and economical keeping, is a wide, open-faced, round-bodied, low-standing animal. The wide face should be set off by full-sized brightish eyes, indicating easy training. And the form of the body usually corresponds with a wide face, the thick-set roundish form being the most economical in keeping up its temperature, while affording the greatest extent of surface for meat cuts. At the same time, thick-set, round-bodied cows are more muscular, and active, and vigorous, than deep, flat-sided or wedge-shaped cows of equal weight or size, whatever their breed may be.

A dragging gait, in any form or breed of cow, indicates weak muscles and loose joints, while strong muscles and active vigor are certainly necessary to admit of good digest-

*The following rules in selecting cows may be relied upon: When the teats taper in a pointed form. the teat-channels and outlets are small; and the flow of milk will be slow and the cow hard to milk. But when the teats are blunt, or a little flattened at the ends, the milk channels and outlets are large, and the cow can be milked with ease and rapidity.

ive power; for without strong digestive ability no cow—or steer—can be thrifty or easy to keep. Two very essential points in a cow are, therefore, an easy, clean-stepping gait, and a large barrel or body.

Undoubtedly, gentle and kind treatment has much influence in establishing good temper—the opposite treatment causing bad temper; but whatever its origin, it is of the first importance that a cow—or steer—have, as a most important indication of character, a *pleasant, comfortable expression of countenance;* the pleasant expression indicating good temper, while the comfortable phase of expression indicates a thrifty habit of body and strong digestive power, showing that such a cow will "pay well for the keeping."

If any particular breed or family of cows has long been trained to the pail, such training should have developed milk-yielding capacity to a considerable extent, and probably in quantity, according to size, as a rule. But beyond adaptation in growth, which comes from training, breed, *per se,* has no particular influence on the capacity to yield milk.*

In selecting cows for milking, the free, easy step, the pleasant and comfortable expression of countenance, and the round, capacious, form of body, are far more important than the line of descent, or family history.

In choosing a cow—or heifer—the YIELD MARK,† which is formed by yield itself, indicates an extent of yield according to the size of the mark, without regard to any particular form of this index of yield; the udder, though

*The leakage of milk from one or more teats of the udder results from relaxation and weakness in the elastic bands—(see p. 38)—which, by contracting, close the teat channels, so stopping the flow of milk. From long tension, from the udder remaining full too long, the calf always emptying it often if allowed to, these contractive bands become relaxed, leaving a small opening through which the milk weeps out or leaks. So practically carrying the udder full of milk too long leads to the leakage from the teats, and cows subject to this weakness should be milked three times a day as the only means of relief.

†See Plates I., II., and V.

sometimes much hidden, corresponding in size with the YIELD MARK, which latter is now known to indicate the maximum yield in nine-tenths of all milk cows.

A light head, horns, tail, and legs are suitable on *small* animals. But the size of the head should be well proportioned to the size of the body, to give good breathing channels through the head-bones. While size of the legs should be equally well proportioned to the weight and pressure of the body they sustain; a well-proportioned size of bone escaping injury from vertical pressure, so preventing injury and pain to the cow or other animal, which is according to reason, proportion of parts, and mechanical rules of necessary proportion.

The "handling qualities" of cattle are said to be good when the skin is moderately thick, and the flesh, with tissue containing some semi-liquid fat underneath, is mellow and yielding to the touch, springing back after pressure when the fingers are removed; and so with the skin itself, when taken up between the fingers and thumb; in good handlers it quickly springs back or contracts to its natural position. An elastic skin and mellow touch indicate a vigorous flow of blood, which pushes the capillary circulation, keeping the skin mellow and supple with a full circulation of good blood, and somewhat oily by the natural exudation through the skin pores. Oil or grease turns yellow when exposed to the air; hence yellow-skinned cattle have evidently more oil in their skins, and handle better than pale-skinned animals.

The weight of the abdomen, and a large udder, or both together, draws the skin down till it fits close over certain projecting bones, as the buttock bones and the hip-bone knobs; and if the skin be mellow and easily movable over these bones, as in good handlers, the skin is sure to be mellow and movable, where there is less weight to draw it downward, and less strain to test its elasticity. But if the skin be tight, and not easily movable, or difficult to lift over the buttocks or hip-bones, the handling is not good, but indicates a hard skin, with a weak circulation and unthrifty habit. Such cattle have frequently rough and coarse hair also, and weak digestive power, with languid motion.

This is the reason and explanation why the best judges always ascertain, by handling, whether the skin be mellow over the hip bones and buttock bones; for if mellow and movable under the heavy strain on these bones, and over the most projecting parts of the ribs, the skin is sure to be *more* mellow and elastic over all the fleshy parts, where there is much less strain, which satisfies the party who examines that the animal is thrifty and may be depended upon, either for breeding or feeding, or fine quality of meat. But if the skin be hard and tight over the hip and buttock bones, the animal will not prove to be either thrifty or a profitable feeder. This is the opinion of experienced feeders and dealers. The handling qualities in cattle are always tested before purchasing by men of experience; as if cattle handle well on the ribs, hips, and buttocks, good handling qualities, or those of any degree between very good and the contrary extreme, will correspond in all other accessible parts, rendering further search as to quality unnecessary. It may be added, however, that the quality of feed, as between fine and soft grasses and hay, and coarse and woody provender and hay, has a modifying influence on the quality of meat and milk.

The animal's structure being formed from its food, must, to a certain extent, correspond with the quality of the food supplied. Harsh, rough feed, with too much exposure, will cause hard skins and rough coats. While roots supply water and make juicy mutton or beef in winter, as juicy grass does in summer. Oily feed softens the hair, giving it lustre; and the advantage of supplying water in roots is: the pulp comes in contact with and gives up a proportion of its moisture to the masticated grain or hay when mixed therewith in the stomach. If not mixed with the drier feed, the moisture of root feed is of little if any more advantage than water in a separate form. When roots are sliced or pulped, and evenly mixed through the dry feed, their watery substance adds much to quantity of blood, and this probably facilitates the distribution of the nourishment afforded by the grain or other dry feed, in either sheep or cattle, and imparts juiciness to the meat.

When much oil escapes through the skin, the meat of the animal will be *less* oily than when most or all of the fat or oil of the feed is retained within its substance. It should have been said, when speaking of the head, that the expression of the face in cattle indicates the state of feeling comfortable or otherwise. A comfortable, satisfied expression of face and eye indicates good health, which is, also, co-existent with good appetite, digestion, and circulation, neither of which is possible, however, without plenty of good air for breathing, and sufficient daily exercise to maintain the vigor and extent of the muscular system, while the blood is completed and made vital as it swiftly passes through the lungs.

"Animal odors," and "animal heat," are designations much employed in dairy regions. But as the "odors" are caused by free gases, such as carburetted hydrogen, etc., passing sometimes from the bowels through their membranes into the cavity of the abdomen, where they are recognized, in opening the carcass; and may also pass into the blood through the membranes of the arteries, and be recognized sometimes in the milk. The odors are not produced in the animal tissues; but may be called gas odors. Animal heat, so called, is simply liberated heat—named blood heat on the thermometer—which is set free in the tissues, from the carbon and other matters of the blood; and is constantly renewed by tissue changes.

Different colors or shades in the *hides* of cattle are met with. For instance: a pale skin indicates thin watery blood; which is probably due to deficient exercise and breathing; while a yellow skin is due to oily exudations daily occuring, and being oxydized, or turned yellow by exposure to the air, as cream becomes yellow and more yellow, the longer it is exposed to the oxygen of the air.

The yellow skin in Devon and other cattle having their skin action vigorously performed, is in a measure probably due to the long repeated daily action of oxygen on the oil of the skin. The dandruff on the udder and elsewhere, being the dried remains of cast-off epithelial cells that are loosened and separated from the skin.

The exudations of the skin indicate to some extent the quality of food and blood; watery blood leaving the skin dry, and the hair harsh, because the exuded water evaporates, leaving the hair dry and rough; while oily exudations adhere to the skin for a considerable time, softening both skin and hair; maintaining the soft mellow condition of each, as a constitutional effect or quality.

A bright or brightish and full eye indicates a vigorous circulation, and full or great nervous force; which, in cattle, is the effect of a vigorous, active muscular system; the nerves in cattle being usually subordinate to muscular growth.

Smooth, waxy horns usually accompany good handling quality of skin; dark colored, dry, rough horns, indicating bad temper, and poor quality in the flesh.

Various Animal Products

Have some distinguishing characteristics. Cream is yellower than milk at first; which seems to show that the ingredients that form fat globules or butter contain more coloring matter than the watery portions of the blood. The chlorophil of grass and green colored hay tends to produce a yellowish shade in the cream, and more carbon is left and retained in the blood of cattle in consequence of restricted exercise, and correspondingly restricted breathing and exhalation, which, in a degree, accounts for the large proportion of cream—not caseine—in milk formed from oily or carbonaceous food.

The tough neck and "tender loin" have opposite causes. The flesh or muscles of the neck are made tough and strong by the frequent and much repeated motion of this part, in grazing, feeding, drinking water, &c., while tenderness in the loin results from the comparative stillness or absence of motion in this part of the fleshy structure; accordingly the muscle or flesh of the shins and legs is tougher than that of the rump, and so on of other parts; those subject to most motion, while the animal lives, being toughened more thereby than the parts that are subject to less or only a little natural movement; tough parts being quite as nutritive as those that are comparatively tender. "Grained beef," or other meat, is the result of fat being deposited upon the surfaces of the various muscles. When small globular masses of fat are found imbedded in the red flesh, fatty degeneration, or commencing decomposition,* is indicated, showing the existence of incipient disease.

Dark colored beef, sometimes called blue, is dark in hue because it contains more carbon and other refuse in the blood-vessels than is found in bright red, juicy meat; and, indeed, dark colored meat is neither wholesome nor nutritive, in any such degree as bright colored meat, which, besides its better color, is far more nutritive from its greater vital quality; as well as from containing better

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*Huxley and Youman's Phys., p. 389.

flavoring qualities and relished juices pertaining to wholesome quality, in all the muscular meat parts of cattle.

Good handling qualities in the skin and flesh are a consequence of good health; and the prime conditions necessary to good health are: pure, wholesome food and water, with *full voluntary exercise*—or enforced activity, if exercise be not freely taken—where the air is pure.

The locomotive organs were given for, and probably perfected by activity; and exercise is necessary to maintain their strength and perfection. So of the lungs, in all locomotive animals; their size and power, and the quantity and purity of the blood, are a consequence of, and nearly proportioned to activity. So there cannot be full vigorous health, or good handling qualities in cattle, unless they are permitted or compelled to take at least a moderate extent of exercise, daily, in pure air and comfortable surroundings.

In another chapter we have alluded to the quality of milk, as being rapidly affected by taints, or bad quality in the food, air, or water of cows. Of course, as to new milk, the quality of the blood is previously deteriorated. Any one desiring wholesome milk, should therefore be careful to ascertain the quality of the feed and water and air consumed by the cows yielding the milk. The flesh of the animal is in a similar manner deteriorated by impure aliment or air; and, of all natural agencies, full and daily active breathing and exhalation are the most important in maintaining a healthy quality of blood. In fact, it is impossible for a healthy quality of blood to be maintained without regular daily exercise, and full breathing in cattle, as well as in horses; the fact of its necessity being recognized for horses, as it must be for cattle, before lung plague, and other diseases that are the result of prohibited exercise, will disappear.

Consistently with the principles advocated in various chapters of this work, a few well-known facts in relation to the influence of activity on meat quality, demands the consideration of consumers everywhere. 1st. The meat of certain animals—sheep, cattle, and poultry—is preferred to, and commands a higher price, and is in greater demand in the English market than the meat of other animals. For, the mutton of Welsh Mountain sheep, and of the South-downs, and Cheviots, all subsisting on short and scant feed, regularly brings from 2 to 3 cents per lb. more, than much larger and fatter mutton; the practical reason being the greater value of the mutton, because the sheep supplying it are more active, performing their excretory breathing functions more fully, and so producing a purer, healthier, and better flavored quality of meat.

The same is true of the Kyloe and other active cattle of Scotland, and the Devon and other active cattle fo England. Their flesh is better flavored from their better quality of blood, which results from greater activity, so that the juicy, sweet meat of active cattle generally sells at from 2 to 4 cents per lb. higher in price than that of inactive cattle.

In poultry, the same distinction holds; the active lively breeds, usually smallish in size, supply the healthiest and best quality of poultry meat.

The same is true of wild fowl and deer; the best quality of meat being obtained from those varieties or breeds that are regularly the most active in getting subsistence, whether on the wing, or, like ducks and geese, in the water, or on foot.

And even in the finny tribe, the same holds; it having been ascertained that the Trout and other fish remaining in their natural habitat—the natural water-courses—are much superior in the quality of their meat to the inactive fish—that are restricted in their natural activity—in small, artificial ponds; the reason being the greater activity, and sounder and purer quality of meat—fowl and fish—resulting from regular activity and blood purification, and better quality of flesh food, resulting from greater activity and fuller excretory breathing by active animals, compared with indolent, slow-motioned animals, whether wearing coats of hair, wool, feathers or silvery scales.

CHAPTER IX.

The Sources of Tenderness in Cattle.

Why some Cattle are tender, while others are hardy.

Much has been said on the subject of "animal heat" by various writers; and tenderness or lack of power to endure exposure, particularly to cold, is usually treated so as to increase inactivity, which undoubtedly increases tenderness. As a farmer, we desire a little more light on these subjects, which we consider as fully as our limited space allows. Tenderness results from deficiency of heat in the skin and the body of the animal, and the source and supply of heat may be therefore considered.

Heat is contained in a latent or stored up inactive state in food, as it also is in the coal or wood used for fuel. When the wood or coal is disorganized by burning, the heat is set free as the fuel burns, and becoming active, instead of latent, it radiates from the points of its liberation in the fire through the walls of the stove, so warming our rooms, in all directions. This result is due to the supply of oxygen in the air, that rushes into the fire, there combining with the carbon and other substances contained in the fuel. The agitation that results from the union of oxygen with elements of fuel, has been called combustion; the result being the disorganization of the fuel, and the liberation, and active distribution of the heat derived from it.

In a somewhat similar manner the food of man and animals contains latent heat; the digestible parts of the food being reduced to small particles by mastication, and by the solvent juices of the stomach and intestines, pass into the blood current, where it constitutes the solid parts of the crude or incompleted material of nutrition. As the blood flows forward through the lungs, the oxygen obtained by breathing combines with various necessary substances, derived from the food and brought forward in the crude blood, the combination being in the red corpuscles, which contain the oxygen that completes the blood, by giving the property that enables it to flow or circulate. The blood will not circulate without the oxygen, that reddens it in the lungs. Hence the oxygen obtained by breathing is the agent that makes it circulate, and supplies a leading nutritive quality. After being made capable of circulating by a due proportion of oxygen, the blood flows forward into the millions of tiny capillary vessels in all parts of the muscles, and muscular organs, bones and skin ; to all parts in which red blood is found.

The blood conveys the pabulum and latent heat into the muscles, skin, and other parts; and the heat is there regularly liberated and made active by the process of assimilation, by which the worn-out material of the parts or organs is detatched and passes away in the venous blood; while the fresh matter brought forward in the artery blood is appropriated in renewing the substance of the tissues, in place of the effete matters that pass away in the venous currents.

The renewal of the tissues in all parts of the body, by assimilation, is a reciprocating vital process, by which about as much worn-out material is detatched as the quantity of fresh material used for renewal by assimilation. It is during this process of assimilation, in which oxygen is the chief agent, that heat is set free, and by its motion becomes sensible, or felt as warmth in all parts of the body, being most sensible in the skin, that organ being most exposed to external impressions of heat or cold. Oxygen brought forward in the arterial blood combines with carbon, liberating heat, and other matters, in the tissues, producing carbonic acid; which, with other material discharged from the tissues, principally from muscular parts, is poisonous in a high degree. Such excretory matters pass outward to the lungs, and to some extent to the skin, but mainly to the lungs, whence they are exhaled as poisonous excretions. During this process of change and nutrition, the most heat passes into the circulation from parts where the most renewal or change in the tissue takes place; considerable blood heat being derived from changes taking place in the liver. In considering the sources of tenderness in cattle, we are, however, chiefly concerned about the sources that supply heat in the muscles and the skin. And it is especially important to remember that the heat that supplies sensible warmth in any part or organ is according to activity in the part. Thus heat is made active and sensible in the muscles of locomotion, according to activity; and this is true of all parts of the body, including the skin.

The sensation of cold affects the skin more than other parts, because the surface is supplied with many nerves, and exposed to loss of heat by evaporation, or the escape of heat into the cooler surrounding air, on the principle of equalization of temperature.

The extent of assimilation during which heat is liberated and becomes sensible as warmth, so increasing the temperature of the blood and skin, is according to two conditions, namely: The activity of cattle, and their corresponding activity of breathing in the first place; and secondly, to the extent of the tissue, or bulk and weight of the organ in which heat is made active, so increasing its warmth. The quantity of heat liberated is according to the extent of flesh or skin substance in which this process occurs during assimilation. Thus there is more heat liberated in a thick skin than in a hide of medium thickness, and more in a moderately thick skin than in a thin one. Hence in any given degree of cold, with equal exercise, thick-skinned cattle suffer least, because they have the largest supply of sensible heat in the skin; and cattle having a moderately thick skin suffer less, because they have more blood and heat in the skin than thin-skinned cattle, which are the most tender of all, because they have the least substance, and the smallest extent of heat liberated in the skin. Thus it appears that thin-skinned cattle are most liable to be tender, or to suffer when exposed to cold. Tenderness in cattle, or other stock, consists mainly in their inability to bear exposure to cold. Cattle of any kind become chilled sooner by evaporation of their skin heat, according to the coldness of the air, and the too small quantity of heat set free in the skin. When they are thin in flesh, and require warmth, less heat is set free in the muscles, because the extent of their substance is reduced. The substance of the muscles is increased or diminished according to action or inactivity in body, breathing, and blood supply, during considerable lengths of time. When exercise, breathing, and blood supply are full, the muscles and the substance of the skin are well supplied with heat, and cattle do *not* set their backs up, as they do when suffering from cold. Chilling and shivering are indications of tenderness, and result from the escape of heat from the skin into the cooler external air. The arching up of the back retards the escape of heat in some degree, by partly closing the pores in portions of the skin where strained more than usual by this process. But the setting up of the back is an evidence of tenderness, and that the animal heat of the skin is escaping by evaporation faster than it is supplied by nutritive changes in the substance of the skin.

A thick coat of fine hair, which also indicates vigor, is a great protection against evaporation and loss of heat;

and such thick coats, as amply demonstrated in the Kyloe and Galloway cattle of Scotland, for ages, as well as thick skins, are developed during activity and exposure in cool or cold weather, as shown in multitudes of Western and Scotch cattle, whose exercise is constant and full. And it is clearly evident that heat can be developed in the body and distributed in the circulation by activity and active breathing by cattle, by which tenderness may be prevented, and ability to bear exposure developed, as fully and by like activity and breathing in cattle, as in colts and work-horses.

It is known that blood is supplied, and that nutrition in the tissues, beyond a mere minimum extent, is rapid or slow, according to activity or motion; and that heat, also, is developed according to activity in local parts, and in the body generally; both facts having been experimentally established in very many instances. And the wide demonstration of the invigorating influence of exercise in developing substance, in skin and muscle, in multitudes of Western cattle, as well as in their general growth, suggests that the cause of tenderness is deficient activity; the evident remedy being special exercise when required, as in the case of horses, when voluntary activity—of which the best colts get the most—is insufficient. It is evident that activity is insufficient when the muscular proportion is reduced below that found in generally active and healthy cattle of any of the various sizes or breeds. It is best, however, to have sufficient blood and liberated heat in the skin; with correspondingly less danger of being chilled in any case, or in any kind of cattle, when exposed to severe cold, rain, or wind.

Cattle that are tender are usually languid in their motions, and generally are thin in their skin or hides. They are, many of them, also, light or slender in their muscular parts; their *in*activity indicating small size in their lungs, and in other muscular and vital organs.

Now, the two questions arise: Why are thin-skinned cattle tender? and why are cattle thin in their enveloping integument, the skin? Good constitution or strong endurance in cattle consists in power to bear exposure without injury, and to resist adverse influences of any kind, as well as to digest thoroughly, to maintain vigor permanently, and to breed readily. All these attributes of good constitution result mainly from abundant daily activity, which, with ample food, insures full muscular growth. Tenderness in cattle, or other farm stock, that are thin-skinned, and susceptible to cold, is, therefore, immediately due to there being too little substance in the hide to admit of a sufficient supply of heat from tissue change to keep the skin comfortably warm; the supply of heat and blood being reduced, as the thickness of the skin and extent of exercise are diminished; and the ability to endure exposure in a cold temperature is reduced, according to the diminished supply of heat, and the reduced extent of assimilation in thin skins, compared with thicker integuments. So the reduced, or small, extent of substance in a thin skin, and the diminished extent of heat liberated within it, is the two-fold cause of the tenderness arising from a reduced supply of heat, and correspondingly feeble ability to bear exposure to cold, in cattle that suffer more than others, because they have thinner skins, and a smaller supply of heat therein.

But why is the skin integument thinner in some cattle than in others? The answer involves important facts and influences.

The skin is a muscular organ, and its substance is formed and maintained by nutrition from the general circulation. The extent of substance and thickness in the skin corresponds, therefore, with the quantity of blood in the general circulation.

2d. The extent of the general circulation is according to the fullness of general muscular growth, and to the size and activity of the breathing and digestive organs, including the skin, which is, also, muscular in quality. The nutrition and thickness of the skin usually maintains a like proportion to the substance of other muscular parts and organs.

3d. The thickness and substance of the skin, in cattle, corresponds, therefore, to the size of the muscles and muscular organs generally.

4th. Full general muscularity in other organs and parts leads to, and includes, corresponding thickness and substance in the skin; as the entire muscular growth, of which the skin is a very important part, is normally according to the extent and vigor of the blood circulation, which—with an ample supply of food—is according to the extent of out-door exercise. So, with an ample supply of food, regular exercise in cool air develops thickness and substance in the skin, and this organ becomes as well supplied with blood, and with heat liberated in its substance, as the other muscular organs or parts.

The proportional development of muscular growth just referred to has long been strikingly illustrated in the Kyloe and Galloway cattle of Scotland, and in Devon and Hereford cattle. And of late years, the influence of prolonged daily activity in developing full proportion in the substance of the skin, as well as in other parts, is strongly and extensively shown in many Short-horn grades, and in millions of common cattle on the herd ranges of western Iowa, and in Nebraska, Kansas, and Colorado, where these multitudes of cattle, and the thousands of horses with them, are exposed to fierce winds, sudden changes, and cold temperatures, without any noticeable tenderness or susceptibility to cold appearing in them. On the contrary, in the greater exposure in that vast wind-swept country, the cattle generally are conspicuous for thickness and substance in their skin-growth; the largest and most thrifty, being best provided with thick inclosing integuments, as we have seen repeatedly, clearly showing that a thick skin is the natural means of protection* against tenderness; and is naturally developed by activity in exposed conditions of wind and cold.

Thin skins and correspondingly reduced extent of muscular parts result from confinement or inactivity. Inactivity, by reducing heat supply leads to fatal results in some cases, in extreme cold; on the other hand increased activity always increases the rate of tissue-renewal in the skin and other parts, and liberates heat in proportion to the activity of the assimilating and excretory processes; and fine thick coats of hair are developed in cattle in exposed situations by activity from the rapid increase of blood, and nutrition in the tissues that result from activity with exposure.

It is known that blood is completed in the lungs, before being supplied in the necessary tissues of the body, beyond a mere minimum amount, rapidly, or slowly, according to exercise or inaction, in local parts, and in the body generally; both facts having been proved true by much experience, and the wide demonstration of the influence of exercise in cattle and horses the country over, and in multitudes of active western cattle, in developing growth in skin and coats, as well as in general size, clearly indicates inac-

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* If it should be said that tenderness, costly shelter, and reduced food value from inactivity, are preferable to activity and abundant skin protection, the reply is that the cattle subjected to inactivity and highly artificial protection, cannot compete with the cattle that are naturally well protected with thick skins and coats of hair; the latter always producing the best quality of meat, as in Scotland, and on the great western grazing ranges, at much less cost to the breeder and feeder. We therefore advocate the maintenance of vigor and food value from activity and full muscularity, as the true basis of intrinsic value in cattle at all times.

tivity or lack of out-door exercise, as the cause of tenderness, and the evident and ready remedy and preventive is special exercise* to any extent required for cattle, according to the rules applied in the conspicuous case of horses, when voluntary activity—of which the best colts get the most—is *insufficient*, as it evidently is when the muscular proportion is reduced below that prevailing in generally active and healthy cattle of any of the various breeds. It is also clear that heat can be developed in the substance of the skin, and in proportion to its thickness in cattle that are regularly active, and make blood according to activity in body and in breathing, this being as true of cattle as of colts and active horses.

*"Exercise also, it is well known, increases the production of heat. It is through the increased activity of the circulation that the body is warmed by exercise. That is the reason why walking is so effectual in warming the feet, and why exercise of any kind raises the temperature of the parts employed, and of the whole body when it is all in motion."—Huxley and Youman's Phys., p. 423.

CHAPTER X.

Breeds of Cattle for the Western Ranges.

Hints on Characteristics and Selection of Cattle.

In considering this subject briefly, it is not necessary to show the details of muscular growth, or why this is so vital and important, as many reasons why this is so, appear in the chapters on Breeding Power, and on Crossing. Our remarks here are therefore chiefly of a practical nature.

The active strength of cattle for any purpose requiring motion and force, is according to the fullness of the muscles severally, and the extent of the system formed by their combined growth, and natural arrangement, larger muscles giving more fullness and strength in any particular organ or part; the power, vigor and enduring character of the whole muscular system of the animal, being greater or less according to the extent and power of the various muscular parts, that together to form the muscular system. Practically, grazing is a muscular function, involving the action of the muscles in the legs, the back and abdomen, in the neck when bending; in masticating, swallowing, &c., &c., and the grazing can be vigorously and fully performed only according to strength and vigor of the muscles it brings into action. And so it is with the muscles brought into use in all other animal exertion or functional activity, whether in the several stages of digestion, in secretory action, in enforcing a vigorous circulation, in breathing, or in walking, in which latter, muscular action is very obvious.

It follows that all strong, healthy muscles in the several organs and parts in the whole system of an ox or cow—as necessarily as in a horse—are required to insure a vigorous and efficient performance of the full series of animal functions, in detail; and that the general vigor power, and endurance of constitution in any breed of cattle, is according to fullness, strength and vigor of their muscular systems or vital growth.

With these brief remarks on physiological bearings of the subject, let us inquire what character of cattle are best fitted by their actual constitution for use in breeding on the great unsheltered ranges beyond eastern Kansas and the Missouri River, and also in the open rich prairies of northern Missouri, and western Iowa, and to the northwest.

Over much of this vast region, embracing many millions of acres, the bunch-grass starts into growth two or three weeks earlier than finer grasses, that do not afford grazing until several weeks later. But the tussocks of bunch-grass are more or less widely *scattered*, so that when first turned out to graze in early spring, cattle have in these open countries much *more walking* and general muscular activity, than is required some weeks later, when the finer, but later grasses grow forth in the spaces between the scattering tussocks of bunch-grass, thus affording more feed while requiring less muscular exertion in gathering it.

This is different from the thick mass of grasses in well sodded pastures, where the Short-horns or other non-muscular cattle flourish, east of the Mississippi; and the difference demands more exertion, greater activity, and stronger muscular power to make and endure the increased exertion required in grazing on the ranges, in contrast with what is necessary on fine grass, in enclosed pastures. And this extra travel in grazing happens at a time when cattle generally are weaker than at other seasons; which again indicates the necessity of a *permanent* fullness of muscle, and muscular power, in cattle that are to be grown on the rich, but scattered grasses of the western grazing grounds.

Then the bleak character of the country, the absence of timber protection in most of it, the prevalence of keen and often-changing winds, and the long distances to water, and to the corrals—all these conditions of growing cattle in the herding country indicate that light-muscled, slow-motioned cattle must increase their muscular proportion before they can be well adapted to so much active exertion; and muscular, vigorous, active, and enduring cattle, are evidently the character of animal required. Light-muscled cattle can bear but little exertion, though in good and abundant feed, and sheltered to supply their lack of skin heat from deficient circulation, but they do well as fat formers. But when these conditions are absent, full-muscled cattle are evidently better adapted to the local climate and requirements of the Western country than any slender-muscled breed of cattle.

The character and quantity of feed on a given area, range, or extent of surface, has a close relation to the question of size in the cattle that can be most profitably raised. On rich bottom lands in the valleys of streams, feed is usually more abundant than in higher situations; and such situations are, therefore, better adapted to large cattle. Accordingly, young Short-horn bulls have been already introduced—and are doubtless rapidly increasing their vital or muscular proportions—where they are permitted to take sufficient exercise; as they are more conformable or plastic in character than breeds with stronger vital growth. The Herefords are large, and with their thick skins and vigororous circulation can endure considerable exposure without loss of flesh. Any breed of cattle—mixed or pure—will rapidly develop muscle by regular activity, such as herding on the plains requires, when they are deficient in muscle.

On bench lands, or second bottoms—which are excellent for grass—the Devons, the perfection of muscular fullness for beef-value, are well fitted to supply vital growth, and enduring vigor, in beginning a nucleus of a middle-sized breed, by crossing, as was long ago shown in the excellent red cattle of "New England," and in similar cattle in detached herds in many parts of the country.

The most vital character is the most enduring, and no breed has marked its descendants more permanently or successfully, or in better color, than the Devons. On account of somewhat smaller size, but fuller muscles, the Devons are more active than the Herefords, and can gather their feed from a wider extent of grazing ground. In muscularity and hardness there is, however, no great difference between Herefords and North Devons.

Let it be added, however, that *small* or "fine" heads will seldom be found, and ought *not* to be, in either breed, as heads that are smaller than in fair proportion to general size indicate *weak* breathing power and a languid circulation, the breathing channels leading through the bones of the head to the nostrils being small, and indicating too small lungs and reduced breathing capacity in cattle of any breed having too fine heads.

It is necessary that cattle should be—as sheep in England and Scotland long have been—adapted in size to the character of the country where they are to subsist; smallish, active breeds—like the Devons, Galloways, and Kyloes—being most suitable for scant feed, in uneven and hilly localities. In such conditions, active, smallish cattle may be profitable, when large breeds could not be successfully sustained or bred. Accordingly, the Galloways—somewhat famous from being resorted to by Colling to invigorate some of his Short-horns—with their thick skins, great vigor, strong forms, and excellent breeding power, seem suitable, from their full muscularity, which has long been a fixed characteristic—and it certainly seems that muscular breeds must be less liable to shrinkage in any new climate or locality, than light-muscled cattle of any breed; as full muscularity enables them to endure either exertion or exposure that would rapidly break down light-muscled, slow-motioned cattle or horses.

The Galloways have an advantage over any other breed named, in being hornless,* their war weapons, or horns, having been bred out by domestication, which adds to their value for convenience in shipping, saving much trouble and inconvenience in all cases where handling and penning together in close quarters are required.

The Kyloes, the *Highland* breed of Scotland, though inured to a harsh climate, are well adapted to the *high* lands and steep slopes contiguous to the plains, as they have long, protecting coats, thick skins, and great muscularity and vigor, with power of endurance in exposure, together with power in transmitting their natural charateristics that is not exceeded, if equaled, in any other cattle in the British Islands. But their small size will not attract the admirers of huge, bulky animals, who will probably pass by the Kyloes, and prefer muscular breeds of larger size, as the Herefords or Devons. The four breeds named as *Muscular* breeds, are all vigorous—and there are other good breeds in Scotland—by reason of the vital stamina, arising from full muscular growth, enabling them to bear exertion and exposure, while increasing in substance, vigor, and value.

Some few petted herds of the Herefords have a great tendency to form fat, this tendency having been acquired from *reduced* exercise and full feeding; but they are well fitted to cross with good native cows—as is successfully being done with Short-horns—on the bottom

*It is said there is prejudice against hornless cattle. But certainly prejudice has no place in connection with scientific breeding or the merits of the cattle.

lands in the Western country. The Devons are of less weight and better travelers, and full of muscular vigor and elasticity, the best middle-sized breed, and well adapted to the undulating lands adjoining rich bottoms.

Size being alluded to, it may be well to show that size will naturally, and by force of circumstances, *conform* to conditions of climate, feed, and topography.

The light-muscled Ayrshire cattle were probably reduced to their present small size by the greater cold, damp, and austerity of the climate of Ayrshire, compared with that of the Tees valley further to the south and east. And certainly, we have a recent instance of several herds of Short-horns being reduced in size by the—to them—*new* condition of living, giving them *new* character and form; or, practically, forming a *new* breed of *middle-sized* cattle, as witnessed only a few years ago by Mr. X. A. Willard,* of Herkimer County, New York, who saw them in California, and wrote that they "were reduced to about the general size of Ayrshires, and were lower on their legs, and rounder in form than Short-horns usually are in the Atlantic States." We try to remember Mr. W.'s meaning, rather than his exact words.

What Short-horn admirers may conclude from the foregoing facts, we cannot say, but several inferences seem to follow: The reduced size of frame indicates less phosphate of lime, or bone-forming material, than is found in abundance in the Blue Grass districts of the West, where Short-horns frequently grow to very large size. Their smaller size in California indicates scantier feed, while their shorter legs and rounder form indicates *fuller muscular growth*, arising necessarily from much greater and longer-continued activity in gathering their feed on the more undulating California slopes and ranges. The spreading or thickening of the muscles of the legs, in climbing steep surfaces,

*As stated in note in answer to our inquiries.

at the same time reduces the length of the muscles, so that their thickness is increased, which is consistent with the tendency of muscular growth, as affected by side-strain on hilly surfaces.

But the fact to remember chiefly, is, that in this recent instance, as with the Devons and Kyloes formerly, natural conditions have *enforced* conformity of growth and form, giving increased muscle and greater vigor, with correspondingly increased power of endurance as the consequence.

Cannot some of the enterprising breeders of Short-horns see in this new family a source from which to derive greater vigor, more vitality, and better form by using for this purpose the California Short-horns? Though this new breed, or family, is not yet so fully developed in muscular proportion as to be quite suitable for the western plains, it is evidently advancing in the right direction, namely, in acquiring increased vigor.

In all probability the rapidly increasing numbers of cattle and breeders of the plains, will find it to their interest and advantage to provide shelter with cheap lumber from Oregon or Arkansas, or to erect low iron frames, covered with some kind of canvas or tarred fabric, for shelter during severe snow storms, as well as from extreme heat and cold. It seems that glazed iron posts, painted wire or rope, and water-proof canvas, could be so combined as to form temporary shelter.

It here occurs to us that Mr. Lewis F. Allen, in his able work on "American Cattle," speaks highly of a hornless local breed of middle-sized cows in use on Long Island, having good coats and skins, and the leading essentials of an economical breed, which seems to afford a chance to combine with the Galloways in forming an extensive breed of hornless cattle.

In any contingency, the vigor and power of cattle are derived from, and according to, muscular or vital growth; and neither native cattle nor any others can be improved in vigor, economy of keeping, or enduring power to withstand adverse influences, except by increased muscular or vital growth, and in vigor, from muscular improvement.

Whatever breeds of cattle may be resorted to in commencing, or whatever course may be adopted in forming new breeds,—new in difference, arising from crossing and modification by changed conditions,—natural conditions of locality will in time enforce conformity in their growth, vigor, and character, as undulating and steep surfaces have originally given rise to the round forms in Devon and Scotch cattle, in Morgan horses, and California Shorthorns.

The small Brittany cattle of France would be well adapted to light soils and scant feed on high table-lands, or where heavier cattle would not thrive well, and would answer as a middle grade between cattle and sheep, in some localities, where the surface is undulating, and feed is scant.

The most important thing to be considered then, is, that full muscular development is the foundation of vigor, and power to bear adverse influences or exposure, by any breed or size of cattle whatever.

It is also important to procure bulls that have been reared in similar conditions—animals that are not enervated—as near as they can be conveniently obtained, so that less change of growth and character during the process of adaptation may be required, and the same holds true in selecting cows for new localities.

Plastic character in cattle is *not* the result of vigor, as it is easily changed character, which is an evidence of instability, and susceptibility to external influences, rather than of stability and vigor. But nature will in time enforce conformity of character to leading local influences; and as plasticity results from weak muscularity, it is best to select a well-formed muscular breed or breeds of suitable size at the outset, thereby saving time required for the development of full muscles. Afterward the natural forces of the locality and climate will impart and complete local fitness, in such degrees or points of growth as may be best suited to the peculiar conditions of the local situation, or character of feed, soil or climate.

CHAPTER XI.

Results of First and Other Crosses.

Influence of Crossing on Meat Quality, and on Breeding Power.

During several generations last past, the practice of crossing, or using thoroughbred bulls on common cows, or the best of them, has been widely advocated, and to a considerable extent carried into practice, particularly by the use of Short-horn bulls—and latterly of Herefords—in the West. The first cross in this way seems to give satisfaction; but the reason has not, to our mind, been sufficiently explained. If our memory is not at fault, experiments have been somewhere made in breeding with second, third, and fourth cross grades, but only with increasingly unsatisfactory results, the further the cross was separated from the *direct* influence of the common *cow* side in the cross. And this, as well as the benefits of crossing, or what is lost in one cross or gained in another, requires further explanation; and fortunately the temper of the times is to search out defects, as well as the sources of excellence, without regard to breed or personal preferences. In this spirit we will try to explain some of the fundamental facts and influences that lead to success or failure in certain crosses, which may suggest some things that are necessary in making other crosses.

The muscular parts of horses and cattle naturally comprise half their weight, and probably contain much more than half the vascular organs and blood circulation. The muscles or muscular organs are vital, or necessary to life; while fat, accumulating without organization is not vital, as it can be dispensed with without endangering life. The vascular system is generally in proportion to muscularity, while the latter is the source of power and activity; and is only maintainable by activity or exercise, as under inaction the muscles waste away—particularly muscles that are active during locomotion and in breathing—and their disorganized substance goes to form fat by mere accretion. The vascular system and vital circulation are, also, reduced according as muscle—which supplies the lean basis of flesh in meat-food—is diminished in quantity or total extent.

The muscular, active breeds of cattle—the Devons, for instance—have become muscular from their greater and continued activity, necessitated, probably, in gathering food; while fat-forming cattle, like many of the Short-horns, have become fat-forming from their indolence or *in*activity, whether voluntary or enforced, or arising from the abundance of their food. The fat-forming tendency in Short-horns, or other breeds of cattle, has been so long established as to be transmissible to their progeny—even to their grades, a fact that is well known.

In good common cattle we have fairly full muscularity—acquired by necessary and long-continued activity; and this supplies the muscular or lean basis of meat in their beef product. In numbers of large Short-horns the proportion of muscle is much smaller than in common cattle, and still smaller than that of the North Devons.

It is very important that vital or muscular growth be transmitted; and the influence of the *cow* in transmission is as strong as that of the bull, this being necessarily so as to vital growth like muscle, in comparison with non-vital or stored-up fat.

When Short-horn bulls are used on common cows the leading tendencies of both muscle and fat-forming are combined, in the first cross or grade. But though the first cross animal inherits sufficient muscle to form a fair proportion of lean, or flesh basis in the beef, the muscle of the first cross grade is, nevertheless, very *considerably reduced* below the proportion in the cow side of the cross; a fact which deserves close consideration.

The vital importance of muscle in breeding, is recognized by taking the "dips" and "infusions" of the greater vitality of muscular cattle—as well as horses—the muscle, being, also, the basis of the nutritive and valuable qualities in beef, containing as it does in addition to the solid elements, the nutritive juices, as well as the flavoring constituents of the meat; these qualities being most abundant in the meat of active muscular animals like the Kyloes and Devon cattle, and in active breeds of sheep, and in venison. To obtain a clearer and approximately correct view of the practical and powerful influence of the muscular and fat-forming characteristics in crossing, a few figures may be employed, and while the proportions of muscle assumed to exist in different breeds of cattle may not be precisely accurate, the proportions varying even in common cattle, and in different families and herds of the same breed, the figures will at least serve to indicate the influence of muscle in connection with crossing, and crosses.

The proportion of muscle in certain pure breeds, and in common cattle, taking that of common cattle as the standard proportion necessary to supply vigor of constitution, and the nutritive basis of meat, in its solids, juices, and flavor, may be estimated as follows: Muscle in common cattle, 100; in Devons, 110; in certain Short-horns, 70; in Alderney cattle, 60; in Herefords, 90; and in Galloways and Chillingham wild cattle, 100. Now if we use a Short-horn bull on a common cow, we have $70+100=170\div2=85$. Thus the first cross gives us 15 per cent *less* muscle in the grade, or half blood, than in the common cow producing it. Suppose the first cross grade to be a heifer, and that a full-blood Short-horn bull be used on her, and we again have Short-horn bull, 70+grade heifer, 85=155÷2=77½, a further reduction of 7½ per cent in muscle in the second cross grade, making 22½ per cent reduction of muscle in second cross grade, or ¼ blood, and much less muscle than exists in common cows. The third cross of Short-horn bull on grades, or ⅛ blood further reduces the proportion of muscle in the grade until the reduction reaches 26 per cent *less* than the proportion of muscle in common cows.

Of course the muscles would be still further reduced, and smaller and weaker in fourth cross grades. But the tendencies of crossing in such direction are sufficiently apparent.

There is nothing in accumulated fat that contributes to prepotency, or power to fix character; if vital as a heat former, it is not as solid structure, nor to supply actual potency, or breeding power. On the contrary, the potency and prepotency, both, are according to extent of muscle, vascularity, and the functional vigor they supply. Now considering the great reduction in ability to take exercise, in the size and the breathing power of the lungs, in the vitalization and quality of the blood, and the power and activity of nearly or quite all the vital organs and functions, reductions that necessarily and certainly must result from such large reductions of muscle, as are shown to take place in the several grades, from the first, second, and third crosses aforesaid, it would be strange indeed if such deteriorating results could possibly give satisfaction. And it would be equally strange if the inferior quality of the meat product of such breeding, the reduced proportion of the fleshy basis and nutritive solids, juices, and flavoring constituents, were satisfactory to the butcher or to the consumer.

We may also say that Colling improved the beef quality of such of his cattle as were concerned, by the acquisition of more muscle from the famous Galloway dip, or cross, and if the Chillingham cattle are as muscular and vigorous as common cattle, Earl Tankerville is now acting wisely in doing the same thing with some of his Short-horns. But to return to the figures:

Suppose a Short-horn bull crossed on an Alderney cow—Short-horn bull, 70+Alderney, 60=130÷2=65. In this case there is 35 per cent *less* muscle in the grade from this cross than in common cattle; and, of course, a corresponding reduction in blood circulation, and in vigor of constitution. But if we try more muscle, in a cross of the Devon, for instance, we have Short-horn bull, 70+Devon cow, 110=180÷2=90, giving 20 per cent *increase* of muscle in the grade over that of the Short-horn, from crossing on the more muscular Devon; and, of course, the juiciness and flavor of the beef from this cross are increased with and in like proportion to increase of muscle that supplies them. And this increased nutritive value explains the reason of this cross being so extensively resorted to in England for connoisseurs and other fastidious consumers of beef meat. If a Devon bull be used on the first Short-horn grade heifer from a common cow, we have, muscle in Devon, 110+Short-horn grade, 85=195÷2=97½, the increase of muscle being 12½ per cent from using a more muscular bull in comparison with the cow. And if a Devon bull be used on common cows, the standard or natural muscularity, as shown in many instances the country over, is thereby increased five per cent or more. But if an Alderney bull be crossed on common cows, the muscular proportion in the grade from this cross is *reduced* to 30 per cent *less* than the muscular proportion in common cattle.

But if we use a Devon bull on an Alderney cow, we have

$110+60=170\div 2=85$, so *increasing* the muscle and food value of the grade from this cross 25 per cent *above* that of the Alderney cow. A cross of common cattle on the Galloway, assuming their muscular proportion to be equal, would not increase their certainty of breeding, nor augment the juices or nutritive value of their beef product, while 25 per cent in nutritive value of meat is gained in the grades by using Devons on Alderneys, the gain being from the muscular side of the cross.

Many other variations and combinations might be suggested, but the proportions and changes already shown are sufficient to suggest what is lost in breeding power in making certain crosses, and what is lost or may be gained in meat value from different or more muscular combinations.

It is also evident that vascularity, and breathing power, and vigor, are reduced by reducing muscle and activity below the natural proportion; breeding capacity, in both the primary and embryonic stages, being usually vigorous and certain, according to the extent of muscle and activity.

When fat can be increased *without reducing exercise and muscle*, breeding power will not be materially impaired. But if muscle and exercise be reduced while the proportion or quantity of fat is increased, in such conditions, breeding power will be reduced, because power and activity, the quantity of vital blood and the secretions derived from it, are reduced generally in the degree that muscle itself is diminished.

The grades from the first cross of Short-horns on common cattle, though their muscle is reduced 15 per cent below the common cattle standard, fatten readily, while they retain sufficient muscle to bear considerable exercise; and their fattening easily is one source of their popularity. Their beef is considerably more juicy than that of pure Short-horns, which is another source of their popularity. But the juicy quality of their beef comes from the muscular or cow side in crossing, from increase of muscle and its contained flavors and juices in the meat. And all grades of Short-horns, as well as full-blooded animals, will increase their fertility, and improve their meat quality as they increase their exercise, muscle, and vital circulation.

The grades of the Channel Island or Lawn cattle, as already shown, gain 25 per cent in muscle, and almost as much in quantity of blood and in vigor, from a cross of the Devon on this slender-muscled family, the Jerseys and Guernseys. But if Jersey bulls are used on common cows, the grade will have 20 per cent *less* muscle than our common cattle, and 20 per cent *more* muscle than the pure bred Channel-Islanders. And there is not a single breed of cattle—not even the petted families of Short-horns—but must have their grades deteriorated as to vigor, muscularity, digestive power, and fertility, by crossing with Jerseys or Guernseys, the reduction of muscle from such crossing, impairing digestive power, and capacity for activity beyond peradventure.

Milk cows, like the Ayrshires, that have become slender in their muscles, need crossing with more muscular stock, like the Galloways or Devons, as an increase in muscular proportion would "infuse" greater vigor into them, while their digestive power would certainly be strengthened by the acquisition of more muscle. This would not change their form, otherwise than to round it out, so improving it, nor reduce their milk-yielding capacity. The Jerseys are also much in need of increased muscle to augment their vigor, and strengthen their breeding capacity, and digestive power.

It will be remembered that Messrs. Colling and Bates, the noted Short-horn breeders, were both shrewd enough to acquire muscle, when they thought it would invigorate, by resorting to more muscular cattle for infusion of new blood, and increase in the extent of blood circulation. And it follows that grades have more blood—whatever its quality—when they derive an increase from the most muscular side of any crosses whatever. The greater value for beef of the half Devon and half Short-horn is a proof of this. Having more muscle, the beef of these grades is more juicy and nutritive, and, therefore, more in demand from its better quality.

When increase of breeding capacity is the object aimed at in crossing, increase in muscularity is the source from which any such increase in fertility is derivable. But muscularity, acquired by crossing, cannot be maintained without adequate muscular activity; while fertility can as certainly, or more certainly, be increased or restored and permanently maintained by increasing the exercise of comparatively inactive and infertile cattle, than by crossing to acquire *more* blood, in enlarged muscular proportion. And, when fertility is fully established or regained, by increase of exercise and muscle, and increased digestive power, as well as efficiency in the secreting organs, particularly concerned in digestion and primary breeding, fertility so restored, or acquired, can certainly be maintained by regular daily exercise, permanently continued, but not in any other way, for any considerable period of time. In other words:

If fertility comparable with that of the muscular, active breeds of cattle, which have been resorted to for infusion or for muscular improvement, be desired, activity corresponding in degree with that of such muscular breeds of cattle is the only obvious means to accomplish this end or purpose. Activity develops and maintains muscularity, or vital growth and power, not only in the muscles of locomotion, but in all the vital organs of excretion, circulation, and digestion, thus supplying vigor and power for primary, as well as embryonic breeding, by means at once natural and effective.

Purity of breed, so-called, of course, supplies particular inbred characteristics to progeny; but it is certain that vigor and muscularity have resulted from exercise, as necessarily in cattle as in horses. And it is equally certain that cattle of large size can be maintained or increased in fertility and vigor by exercise, as is done in the smaller breeds; and fertility is now being in this way increased in many young Short-horn bulls in the West.

By crossing with such animals as can supply an increased muscular flesh-basis, both increased breeding power and augmented food value are obtained. But by crossing so as to diminish the muscular proportion, opposite and inferior results in the progeny are produced. A full muscular basis of flesh is necessary in any cross, grade or breed, to supply the full circulation and vigor that insure fertility and constitution, with vitality and power of endurance.

It has been intimated by others that when the grades of a breed are superior to the pure-bred, or full-blooded animals, used in a cross, improvement cannot be expected from employing such full-blood animals, *within the limits of the breed*, which is equivalent to saying that when an improvement has been made in the grade,—and not being derived from the inbred or full blood,—it must have been derived from the common cattle, or whatever cattle were crossed upon. This shows that the improvement in grades, as compared with full-blooded sires, or dams, comes from the *more muscular* side, or animal employed in a cross. We believe this was said in reference to Jersey crosses, and have shown the natural basis from which grades derive qualities that are superior to those of pure bred or inbred cattle, in several important particulars. Such results go to show that the real sources of improvement have not been fully understood, or if understood—by such men as Colling and Bates—have not been explained, or acknowledged by breeders generally.

Improvement from some accidental or hap-hazard cross has been noticed, and with such fact, we have had to be content without further explanation. But it really seems desirable that the probable effects of certain combinations should be approximately known before the crosses are made. And we believe the time is rapidly approaching when less will be said about "strains" and "infusions," and more will be admitted as to the importance of muscle, and other things that are necessary to supply enduring vigor, and improve the intrinsic value of cattle.

It is a fortunate circumstance that intrinsic value in cattle cannot be augmented without also improving the nutritive quality of their meat products. And that increased nutritive qualities, either in the substance of the meat or in its juices and flavors, either and all, can only be derived from an increased extent in the muscular proportion of the animals, or breeds that are alleged to be improved. And this chapter has been written with the purpose of calling attention to some of the fundamental sources from which both breeding value and food value, that will benefit both producers and consumers of beef food, is derivable with certainty, and by means within the reach of all breeders of cattle.

CHAPTER XII.

Sources of Breeding Power and Sterility.

Exercise a Chief Necessity in Maintaining Breeding Power.

From time to time there has been failure in the breeding power in cattle of the Short-horn breed, and such failures are not unknown at the present day. The noted Short-horn breeder, Bates, "thrice infused fresh blood into his herd,"* and Colling, also, took a "dip" of Galloway blood, which was an advantage, in improving their muscle, to some of his Short-horns; while the present Earl Tankerville is now "infusing" new blood from the wild Chillingham cattle into some of his Short-horns. It appears also from Mr. Wright's† statement that "many more calves are born cripples from this breed than from any less closely bred cattle," which is an evidence of defective breeding power in such instances, and, doubtless, there are many unreported instances of failure in primary, as well as in other stages of breeding.

It is evident that the progeny produced is believed to be improved in breeding power and otherwise by infusions of blood from the active breeds resorted to; but we shall see that mere mixing of blood, without increasing muscle, would not improve unless the blood were superior in quality or increased in quantity, or both together; and, in fact, the blood infused by crossing with more active breeds is superior in its quality, as the blood of cattle is more pure or better in quality in proportion to their ac-

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* See Darwin's Ani. Und. Domesti., Vol. II., p. 147.

† See Darwin's Ani. Und. Domesti., Vol. II., p. 147.

tivity; while more blood is made by the grade, because it acquires more muscle, and thereby more power to digest food and form blood. But improvement so acquired can be only quite transient, because it does not rest on any basis really pertaining to, or developed by, the breed receiving the infusion of blood.

There are several sources of breeding power in auxiliary degrees, but the main source of successful breeding power in the degree that is necessary to perpetuate a race or breed of cattle *un*impaired, consists in plenty of vital blood; by vital blood being meant that quality which contains a natural proportion of oxygen, about half the mass of the blood being composed of crude, unassimilable matter; which, however, serves, by its distensive bulk, to keep the blood-vessels of their proper size.

The gross bulk of the blood before it goes to the lungs, is *not* vitalized or complete, as blood; for it quickly ceases to flow or to nourish the tissues unless it contain vital air or oxygen; but after it receives the necessary proportion of oxygen, mixed with 45 per cent of its bulk, the blood is vitalized, or completed in its elements, and therefore circulates and nourishes the tissues. The crude blood is not capable of sustaining life, but after it has passed through the lungs nearly half the bulk of the blood becomes nutritive from its acquisition of oxygen. Hence it is BREATHING *that makes the blood vital or capable of sustaining life.*

Oxygen is the principal agent in the renewal of the vital structure in all parts which receive blood, and its constant use for this renewal, and to remove dead or worn matter, is the reason that *blood divested of oxygen will not circulate.* So the circulation of the blood, in mass, is due to its life-giving oxygen; and even the fine fibres of muscle die when divested of this vital element. Crude blood may be formed in large bulk by large cattle, and may contain the other necessary ingredients, as albumen, phosphate, etc.;

but these can only be used in proportion to the quantity of oxygen contained in the artery circulation. Hence the *natural proportion of oxygen* supplied by breathing is indispensable alike to circulation of the blood and the nutrition of the tissues.

While breathing vitalizes or gives life to the blood, it is a dual and reciprocating process, purifying by the exhalation of poisonous and dead matter, while it vivifies and vitalizes by the inhalation of oxygen. Hence the vital quality of the blood depends *mainly* on breathing; and the natural proportion of oxygen can only be supplied by the natural extent of *breathing*, which again depends upon, and can only be according to, the natural degree of *muscular motion, or sufficient regular exercise.*

The various vital secretions cannot, of course, be extracted from the crude, unassimilable portion of the blood, but are derived from its vital assimilable qualities, which are used in proportion to the oxygen, which causes it to circulate. Hence the quantity of the digestive juices, and of the primary breeding organisms—the spermatozoa in the male and the ova in the female—cannot exceed a small and strictly limited proportion to the vital elements of the blood they are formed from. So that success, even in primary breeding itself, depends upon *exercise and breathing*, which both insure its circulation, and give life as well as motion to the blood.

The nutritive proportion of the blood probably comprises not far from half its entire bulk; the other moiety serving to increase the size of the blood-vessels, and the extent of their surface, so increasing the area of secretive action, and maintaining the size of the blood channels generally.

Heat increases with the increase of blood, in the region of the ovaries, which, by its greater extent, brings on Coupling-heat; but we cannot infer from this that the vital spermatozoa and equally vital ova are developed or matured from the crude parts of the blood. On the contrary, both these primary organisms are derived from the most vital elements of the total circulation, and are subordinate to the quantity of its vital qualities.

In the embryo stage of breeding, there can be no increase by growth in any larger degree than the oxygenized blood supply increases; and as this is closely *proportioned to breathing*, and the breathing is closely *proportioned to exercise*,—a fact that is practically recognized by horse-breeders, who are careful to have their *brood* mares take regular exercise,—it is clearly certain that an increase in vitalized blood, and increase in embryo size, depend on the natural extent of breathing and activity being regularly maintained, as a necessary condition precedent to making full vital growth and size in developing the embryo before its birth and breathing.

The suckling stage of breeding is naturally necessary until the calf becomes able to graze and masticate food, when this final stage of breeding ends.

The milk is not colored, because the calf colors and vitalizes its own blood by its own breathing; but the nutritive quality of the milk depends upon that of the cow's blood—which varies widely, according to the ingredients of the cow's food, and extent of its necessary vital qualities, which again depends very much upon regular exercise, which in its natural degree is as vitally necessary for cows as for horses.

We see this law practically in operation in the muscular breeds of cattle, as the Devons, Galloways, Kyloes, Herefords, and generally in common cattle, in which there is no lack of fertility, because there is sufficient exercise to supply the necessary quality of blood that insures fertility.

It is evident, then, that infertility in inactive cattle of any breed, whether large or small, but chiefly in Short-horns, results from some leading influence, which does not affect active cattle like most of those just named, and the leading difference at once appears in the wide contrast between the degree of exercise taken by inactive or indolent cattle, and that taken by the active, muscular breeds. Inactivity leads to reduction of muscle, and to a corresponding increase in the quantity and proportion of solid fatty accumulations. But muscles rapidly or gradually die and waste from disease or inaction, because their supply of oxygen in the red blood ceases, and then the dead substance of the fibres is decomposed, and added to accumulated fat. This results gradually when exercise is gradually reduced, and rapidly under abrupt and close confinement.

Life and large size may, it is true, be maintained in cattle with a small amount of exercise, and a small proportion of muscular growth and little vitality; but without abundant food, fat, and the fat-forming tendency are increased in proportion as muscularity is reduced by inactivity. The muscular parts comprise about half the natural proportion and substance of active cattle, and, including the vital organs, blood-vessels, and skin, which are all muscular, nearly the whole of the red blood, or nutritive circulation, is contained in the muscles and muscular parts or organs.

Another important fact is, that the size of the vital organs generally, as well as that of the muscles proper, is proportioned to their use or activity, within normal limits, the limits being determined by the extent of regular use, this being conspicuously true of the lungs and digestive organs, compared with the general size of animals.

The extent of the red-blood circulation is reduced as regular exercise is reduced, because the demand for nutritive blood for the renewal of active parts, as well as the digestive power to supply such demand, are each diminished in the degree that activity is reduced, while the quantity of vitalized blood is certainly diminished according to the reduced size and activity of the lungs; breathing necessarily corresponding with any reductions in exercise.

In addition to forestated causes of a reduced quantity of blood in circulation, and the reduced vital quality in that reduced quantity, the encroaching and obstructive influence of fat amongst the tissues is manifestly a great impediment to a full and free circulation, and to strong breeding power; as a full and free circulation requires full, unobstructed space.

In active muscular animals, as in horses and active cattle, the circulation is not crowded or obstructed by encroaching quantities of fat. This exemption from obstructing fat is the reason why lean dogs, lean horses, and lean working bulls, are sure in breeding; their blood is full in quantity, because they are active, and there is full space for the circulation to freely fill and occupy; their blood being also vital in quality from their greater activity, and the greater extent of their breathing. In a barrel full of beef and brine, the quantity of brine cannot be increased without reducing the quantity of beef. In cattle, the quantity of fat cannot be increased without reducing the quantity of muscle, and also the size and power of the muscular organs and the quantity of blood in circulation.

The reduced quantity of the red blood is also impaired in vital quality, by the retention of carbonic acid and other excretory poisons, which accumulate in the blood from reduced or prohibited activity, and reduced breathing; the vital secretions of primary breeding in both sexes—which necessarily depend closely on the vital quality of the blood—being necessarily diminished, both by reduced quantity and deteriorated quality of the general circulation.

Breeding power in animals varies with activity, and the quantity of a good quality of blood. Bulls may be fertile when used with only a few cows, but may not be fertile with many rather fat cows; or bulls may be fertile and infertile by turns, when too fat, according to the transient quality of their blood, the blood quality rapidly improving or deteriorating according to exercise and blood vitalization by breathing, which is shown in the practice of driving; as, from Prof. Tanner's account, was practiced with cows by James Webb—the eminent sheep breeder—and some other breeders in England, and is resorted to in some instances in this country, with results that usually insure breeding. The increased extent of breathing that results from driving and greater activity, increases the leading vital quality—the oxygen—which makes a larger proportion of the blood available for organization, even a small improvement in quality of blood, in this way, being sufficient to change the condition, by maturing previously immature ova; and as heat is developed in the tissues, and circulated in the blood *according to activity*, the increased heat arising from exercise in proximity with the ova may in some cases soon change infertility to fecundity.

But it is neither necessary nor expedient to take any such risk, as moderate regular exercise, every day, would change the uncertain narrow margin of varying chance into a broad path of established certainty of breeding.

We see this principle well illustrated in the active muscular breeds of animals, even in large cattle, as in many of the Herefords, that have a fair share of muscularity, and retain their full circulation and breeding power by moderate but regular exercise.

Breathing, and the vitalization of the blood, may be increased 100 per cent, or more, by active exercise and breathing, in contrast with the slow breathing of cattle under confinement; and it is probable that both initial and embryo breeding capacity, may—with sufficient suitable food, such as good grass—be increased to a great extent, in contrast with the small extent of fertility which hangs on the narrow edge of transient and fitful exercise by chance merely.

The infertility of indolent or inactive cattle is due immediately to an insufficient quantity of vitalized or oxygenated blood, this defect being due to a diminished total in circulation, the reduction in blood resulting from wasting of muscle, and increase of fat; the reduced vitalization of the blood being the consequence of the diminished breathing, resulting from reduced activity.

The reduced activity of many Short-horns resulted originally from the augmented food, which diminished the necessity for exercise in gathering food, in the proportion that the food supply was increased in abundance. This took away the natural incentive to activity, and increased the extent of inactive repose. Reduced activity in this way led to a reduction in muscular substance and proportion, and to an increase of fat, the fat-forming tendency being thus clearly traceable to reduced exercise, and an equally reduced rate and extent of breathing.

To increase the fat-forming tendency still further, various kinds of fat-forming food, such as oil-cake, shorts, corn meal, and others were supplied, and even added to abundance of grass, and in some instances under pretty close confinement, the result being in beef cattle, in the words of Prof. E. W. Stewart, "monster Christmas cattle,*

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* It seems to be a fact that marbled meat results from fatty degeneration of muscle, or the death of portions of muscular tissue. See Huxley and Youmans' Physiology, page 389.

whose skins are filled with tallow, instead of juicy, *marbled* meat," in far too many instances.

Of course the same inactive fat-forming tendency is established in the cows of inactive fat-forming herds, with the effect of greatly reducing their vitality and fecundity, the vital blood being so far reduced in quantity, and life, or circulating quality, that numbers of costly cows have died in their prime from not having a sufficient quantity of vital blood to maintain life.

Motion in animals is caused by muscular contraction. Blood divested of vital oxygen is practically dead, as it will not circulate; but when vitalized by oxygen the blood enters the substance of the muscles and muscular organs, as the muscles thicken by expanding, while their length is contracted; so exercise increases the supply of blood in muscular structures, by increasing the number of muscular motions from contraction. This is the law, and the way in which exercise increases growth. Exercise similarly increases breathing, also, thus adding its life element to the blood, and completing its fitness to promote growth, and this in extent according to activity, or the number of regular muscular contractions, thus preparing a supply of vitalized blood according to activity and demand, a suitable supply of food being, of course, provided and consumed.

By muscular activity, active cattle prevent their muscles from wasting, and maintain the size of their vital organs by the activity and fullness of their circulation, the active exercise maintaining full breathing activity, thus completing the nutritive quality of the blood. It is also true, that the development of heat in the tissues, and warmth in all parts of the body, is the immediate result of active breathing, corresponding with exercise, as we all know experimentally—our own life having been saved when in danger of freezing, by developing heat by rapid activity.

The extent of muscle, and the size of muscular organs that are necessary to insure permanent breeding power or fertility, is that extent and proportion which moderate daily exercise, regularly continued, develops in young or growing cattle—in the Devons, for instance—and maintains in them after they reach full size or mature growth, muscle for activity, and space for a full circulation being developed and established in this necessary way; breeding capacity is as certainly and co-equally established by the same natural means.

The extent of exercise that is necessary to prevent the waste of the muscles by disorganization of their fibre, from lack of circulation, will also maintain the full proper proportion of muscular parts, and a full extent of breathing, and of vitalized blood, and breeding power or fecundity. We see proofs and examples of this in horses and active cattle on every hand, making the sources and conditions of breeding power sufficiently clear and evident, and showing that fertility may be increased when necessary, or maintained when sufficient, by management of such a practical and simple character that sterility in inactive, fat-forming cattle need not continue, unless something of much less importance—as fat, for instance, to supply the place of deficient muscle, that results from deficient exercise —be preferably maintained by restricting or prohibiting necessary activity.

A concluding suggestion occurs to us, namely: That developing and maintaining vital power in cattle, power to transmit vigorous qualities effectively, by developing muscular proportion and maintaining it; and so increasing nutritive value in their meat products, are objects worthy the ambition of the breeders, not alone of different families of the same breed, but of rival breeds, and of all leading breeds of cattle. In pursuing such a policy, neither beauty of form or of color need be sacrificed or neglected;

while there must arise great public advantage, with a large share of individual gain, as well as enduring satisfaction and reputation, according to the augmented value and success resulting from such a course of breeding. And the signs of the times, in the growing demand for fleshy, juicy beef, and the same quality in pork-meat, indicate that nutritive value—which is coincident with the muscular basis of sure breeding capacity—will be certainly and increasingly demanded in the near future; and such a policy, and its results, the consumers of meat will be generally sure to approve.

CHAPTER XIII.

Origin of Character in Old Breeds of Cattle.

Natural Conditions Giving Rise to Their Peculiarities.

All cattle that continue long in distinct locations having peculiar features of climate, topography, soil, etc., acquire peculiar character from the influence of the local conditions they grow in. This could not be otherwise, as the forces affecting growth and character, such as cold and damp, and abundance and quality of feed, vary more or less in every locality. What appears highly probable is, that nearly or quite all the best breeds of cattle and horses are chiefly formed and originate under local influences, combined with unconscious selection, previous to their becoming generally known, specially selected, or much disseminated. Accordingly, we shall try to point out certain prominent and, in some cases, peculiar traits in a number of long-known British breeds of cattle, and others; and to give such explanations as seem applicable of the conditions or influences that gave origin to their leading or most obvious characteristics. A few underlying facts and principles may be noted. Parts of the system, *i. e.*, kinds of growth, are vital or necessary to life in proportion to their vascularity, to the quantity of blood and blood-vessels they contain, as well as to their contractility and active use. Thus, while fat is inelastic, containing little blood, all animal motions result from active muscular elasticity, while half the circulation of the body is contained in the muscular tissues, and nearly all of it in organs that are muscular in their structure, thus making circulation and nutrition both dependent upon the muscular tissues and their extent, according to that of the general muscular structure. In some cases, disproportionate size is caused in certain parts by largely increased use of the muscles, and increased blood supply, according to increased motion and demand. This is seen in the large hind-quarters of cows that yield much milk for their size; the large supply of blood in the hind-quarter artery system, and the capacity of the arteries being augmented by increased quantities of blood to supply the increasing demand in forming milk. In such formed cows the gradual increase of blood in the hind parts leaves the fore parts *reduced* in proportion, so giving rise to the wedge-shaped form.

This modification of form may take place to some extent after maturity; but generally at mature age, which varies somewhat, full growth is attained. Hence, though the proportion of parts may be somewhat altered, there is no general increase in growth after mature age; and as a widely general rule the general muscular development in cattle of any breed is according to the extent of their regular activity during the growing period, or until mature age is reached.

Abundance of accessible feed undoubtedly reduces the extent of voluntary exercise, causing a corresponding reduction in muscular proportion to total size, in this way developing the fat-forming tendency by reducing activity. But in reducing muscular proportion by reducing activity, thus increasing size at the expense of muscle, the circulation, vigor, activity, and breeding capacity are all diminished.

When enlargement in size takes place, with reduced activity, vigor and constitutional vitality, or power to live, is reduced as muscular proportion is diminished.

The Devons.

The North Devonshire, or Devon Cattle, are remarkable for their muscularity, fine forms, and also for their strong vitality, as shown in their power of reproducing their own form, color, and general characteristics in their progeny or their grades. They are also famous for their power and activity as working cattle wherever known, their working ability being a consequence of superior muscular development. The natural combinations giving rise to their fine red color are not clearly known; but their color being established by natural agencies, and, noticed as it was sure to be by observing cattle men, was concentrated and handed down by selection and inheritance.

The Devons, as to their distinctive characteristics, are very ancient, and none of their qualities are derived from any known breed, as they have never shown occasion for improvement by crossing. And, in fact, their muscularity and constitutional vigor are so naturally fixed and perfect that crossing would be more likely to injure than to improve them. Next to their beauty and uniformity of color, their compact, full, and well-proportioned muscularity, is the leading characteristic of Devon cattle.

Originating some centuries ago, before improved grasses and pastures were established, the wild grasses were thinly scattered, affording them only scant feed, and occasioning much necessary exercise in searching for and gathering their subsistence. By such natural exercise, continued through many ages, and very many generations, the full muscles of the breed have been developed and compacted; and so of their bones, till each bears a due proportion to the other, and both to the size of the cattle in all parts of their frame-work and growth.

Their circulation and reproductive power are as full and perfect as their vital growth, their breeding power being according to activity, muscularity, and fullness and purity of the circulation giving it origin.

The rounded form of the breed has probably been increased by the peculiar tension required in exercise on *side* hills and *steep* surfaces, which are abundant in North Devonshire, where selections of the best forms were made, first by admirers, and afterwards by breeders of means. But the characteristic muscular perfection, activity, and power of transmitting their own color, form, and general qualities, were established by natural agencies long before they became widely known as a breed, or much distributed. And by their continued activity in a climate necessitating it, they have maintained through ages and centuries their fixed and very strong power of breeding, and marking their descendants, as is conspicuously shown in their relatives, the *red cattle of New England*, and in detached herds and families of Devons, and their grades in nearly or quite all the Northern and Middle States.

The strongly-fixed reproductive power of the Devons is well demonstrated in the New England red cattle; as even there their grades reproduce the Devon color and form, and their muscularity also to a considerable extent. The hilly pastures of the Eastern States tend to strengthen and maintain their inherited fullness of muscular growth.

The Ayrshire Cattle,

though now a leading dairy breed, are essentially Scotch Short-horns, or Teeswaters, reduced in size, with greater fixity of character, however. Whoever imported their ancestry to the damp climate and moist soil of Ayrshire, it was quite a matter of course that they should work their way to that location, which gave them its name, as the means of establishing a dairy breed in a humid climate, by their acclimation and successful adaptation to that locality.

But few men are named as breeders of Ayrshire cattle in their early days, and no mystic lore is wasted on them. And this is needless, as whatever may be said, their progenitors must have been diminished in size upon going into the cooler and much damper climate of Ayrshire, as under such a change more food was required for nourishment and to maintain the normal blood temperature and fluidity. While they get a less total of feed on Ayrshire soils, and more activity being required in gathering it than on other soils, on the banks of the Tees, or in similar localities, with less food and less time for repose, and more active exertion in a cooler temperature, these new conditions must have gradually but surely reduced the size of the larger Teeswater to that of the smaller Ayrshire, and so the latter cattle became a *new* local breed, from the force of local climate and other attendant conditions.

The Ayrshire is not a muscular animal; they did not inherit much muscularity, while their muscular proportion would not be much developed or increased, while so much of the muscle-forming material, the fibrin, goes into the the pail as caseine from this dairy breed. But the local character of the Ayrshire climate, its foggy moisture, supplying a large proportion of moisture in the feed and blood, and in the milk formed from them, together with careful milking, naturally increased their yield and the size of their udders to their well-known large extent. But it is doubtful if large yield, developed in a moist climate, can be long maintained in a dry climate, otherwise than by moist special feed, and careful attention to watering the cows; but with such care their full yield may probably be maintained.*

THE KYLOE, OR WESTERN HIGHLAND CATTLE

of the Islands of west Scotland are, perhaps, unequaled for

*It is remarkable that milkers generally milk large-yielding cows cleaner than those of less yield, possibly because they feel more encouraged in one case than in the other.

thrift, excellent form, and vigor of constitution. The climate is damp and uncomfortable, frequently chilling the blood of cattle or people not used to it, and it is probable that these conditions of the climate in the Hebrides, led to the development of the longer coats of hair to shelter and protect the skin from the chilling influences of uncomfortable, damp, and boisterous winds. Their remarkably long-hair coats serve this purpose admirably, and, it is reasonable to suppose, were naturally produced to supply the needed protection.

The scarcity of food, for ages—perhaps for centuries—compelled constant activity in the breed; and this on hilly, precipitous surfaces, led to their full muscular development, and low compact form, which long-continued exercise in like conditions, coupled with inherited tendencies, have in time become so firmly fixed that no improvement can be made in the Kyloes by crossing; this, their owners state, having been proved by experiment.

The Kyloe cattle are exceedingly thrifty; and though small, dressing only 600 to 800 lbs., they are the best adapted breed, having fixed character, to bear exposure in the high latitudes of the United States, and to scant feed in the cool climates of high ranges, where they would not be likely to shrink in size—if well supplied with water—from the influence of any probable exposure. Such cattle would do well, and pay well, where larger, less muscular, and less hardy breeds would shrink and fail.

The Galloway Cattle

are somewhat larger, but still of smallish size, bred in an inland and considerably warmer climate than that of the Western Islands. But they have thick hides, and shorter hair, the somewhat dryer inland air where the Galloways* are chiefly raised, reducing the necessity for

*There are excellent Galloways in Dodge Co., Wisconsin.

such long coats as the Kyloes have. They are not quite so muscular as the Kyloes, as their pastures supply more food, with less occasion for great exertion. Still the Galloways are a full-muscled breed, having, consequently, much vigor and constitution, and also from the same causes, strong breeding power. In general form and character they occupy about a middle position between the Devons and Kyloes, but more nearly resembling the latter, as their habitats and climates more nearly approach each other.

A convenient characteristic of the Galloways is their being hornless,* which is a strong recommendation—particularly to non-combatants—as horns are a nuisance to all who have to handle cattle in cars or other close quarters, besides the hooking and bruising in yards and pens. Galloways are historically famous, from having been resorted to for improving some of the Colling Short-horns, the natural muscularity and vigor of the breed enabling the Galloway to impart more muscle and vigor to the less muscular Short-horns employed in the cross.

THE SUFFOLK CATTLE,

many of them dun-colored, have not yet achieved a wide celebrity. They are medium in size, pretty compact in form, and being hornless, afford another source for selection in establishing non-fighting or polled breeds in the West, where so many animals herd together, and the economical policy is that of peace. The early history of the Suffolks is not sufficiently known to enable us to judge of the influences originating their peculiarities, of which little has been ascertained.

THE SHORT-HORN CATTLE

were formerly known as the Durhams, which were pre-

* We consider the alleged preference for horned cattle just as well grounded as a preference for horned sheep, beauty and utility being equal in either case.

viously known as the Teeswaters, showing several changes in name, while there have also been changes in style, form, and color. The origin of color cannot be traced beyond the influence of transmission. In consequence of many modifications, the Short-horns are plastic in constitution. As they stand, the character of the breed is somewhat varied, which is due to influences that are unimportant. They are eminently the breed of wealthy amateurs, as—while they are not suited to common, or scant food, or to poor or thin soils—they do well where feed is rich and abundant, where there is but little exposure. In Ohio, Kentucky, and Illinois, where bone-forming material is abundant in the blue grass pastures, the Short-horns become large in frame, fine in figure, and picturesque in appearance. But circumstances alter cases; for, on the dry ranges of California, where the grass is only scattering, several herds of Short-horns have been subject to different local influences—without either blue grass or abundance of any kind of feed—the result being that they have been reduced to about the size of the Ayrshires, while their muscular proportion is much increased, as shown in their rounded low forms, and activity. In fact, their increased activity in quest of necessary food has developed corresponding muscularity, which shows an improvement in the chief source of vigor and breeding power; while it eminently proves the influence of activity as the natural means of increasing or restoring muscular proportion and constitutional power; either to endure necessary exposure without injury, or as the basis of reproductive ability and food value.

THE HEREFORDS,

now being considerably diffused in the West—are a very ancient breed, thought by some to be from the same ancestry as the Devons, which breed they resemble in muscularity and vigor, and to some extent in their color. There have been partial modifications, however, in their color, from fancy; but we are glad to say that in the breed generally, their natural vigor is retained.

How the massive, thick-set form of the Hereford originated, can only be conjectured, but probably certain families of Devons, of more than ordinary size, were selected and taken to richer soils. It is certain that many of them are bred on richer soils, in the counties of Hereford, Salop, Worcester, and Gloucester, than those of the north Devon country, and that they are the favorite large breed with the tenant farmers who know them, in the counties named, in England.

As a breed the Herefords are hardy, sure breeders, and very thrifty on sufficient feed, while they and their grades are favorites with the butchers on account of the juicy and superior food quality of their meat, which is due to full muscularity.

Alderney

is the old general name of the cattle bred on the three Channel Islands, off the coast of Normandy, between England and France. They are a small breed, having very little muscular development, because they have for ages been usually tethered in their native Islands, there not being convenient space for pasture lots of any importance. Being restricted from exercise by tethering, of course they could not make the muscular development which is seen in active cattle, to result from regular activity. Accordingly, the three Alderney families are very light in their muscular parts and proportion. So, in times past, they were considered a "pony" or pet breed. Latterly they have been brought more into notice on account of the *yellow color* of their cream and butter, some of them yielding considerable and rich milk. But as a breed they are too small to consume or digest much food, while much of what they do consume goes into the pail, not being required for maintaining their slender muscular growth, or enlarging their size, as is done in active breeds, like the Devons, etc., by exercise while young. What appears probable is:—

That their quality and the yellow color of their cream and butter can only be maintained by *preventing* regular activity, either by tethering or other close confinement.

That exercise, in the ordinary way of pasturing, will reduce their yield of butter, while increasing the quantity of their milk.

That if allowed to run with common dairy herds, in the ordinary way, they will gradually cease to supply so yellow a colored butter, and in a few generations may lose their distinctive character as yellow-butter cows.

That, as lawn pets, or for soiling on limited areas, they will give satisfaction, on account of their docility, which has been acquired from long handling under confinement. And they are well adapted for keeping in separate or small herds, by those having dainty preferences or tastes. But for general dairy cows, for the use of ordinary farmers, they are not so suitable, as there are simpler and cheaper methods of coloring butter legitimately—as with yellow corn meal, for instance—than by keeping underlings in dairy herds.

The Alderney, Jersey, and Guernsey, are from long training, and small size, quite docile, and properly lawn cows. No others equal them for this purpose, or for soiling from the cottage garden; but they are not, we believe, the size or character of cow that dairymen or farmers can best afford to keep on their farms for general dairy purposes.

Holstein, or Dutch Cows,

have attracted much attention of late years, chiefly on account of their very large yield, they being probably unequaled amongst old breeds in this respect. They are a short-horned breed, and probably the old Teeswaters originated in the same old dairy country, namely, the Netherlands, or coast country of Western Europe.

Three things have combined, through ages and centuries, to make the *yield* of the low country cows along the coast country of Western Europe, large or very large.

1st. The humid atmosphere of the coast country from Holland to Denmark supplies a larger proportion of moisture in both the breathing-air and in green and dry feed, than is found in the feed of *dry* climates. This juiciness of their feed has led to their making a large *bulk* of blood, as shown by their yield, causing large size in the cows, a large flow of milk, and large size in their udders from storing large yields, as a long-continued habit.

2d. The great and painstaking care of the people who tend and milk these cows, in milking closely and regularly, to the last drop, has had its share, coupled with gentle treatment, in causing them to give down freely to supply the demand, thus increasing their yield.

3d. They have inherited large udder-supplying artery capacity, and the tendency to yield much milk by reason of moisture and bulk in their food and blood, through scores of ages; and the increase in their yield has been so *gradual* that their yielding characteristic has been firmly established by growth in the udder-supplying *arteries* of the breed; the tendency being fostered by care on every hand, for which reasons together, the imported Dutch cows have their good yielding capacity more inbred and fixed than any other dairy breed. And this fixed capacity will probably continue in the imported cows, if they are supplied with *moist* food and water, as they probably will be. But yield may decline in their descendants, because of our drier climate and feed, unless they are supplied with moist feed sufficiently to counteract the influences of our dry climate. But the long-established tendency of the breed will be long continued with suitable feed and care.

From the foregoing instances of natural development by natural conditions and influences, it is sufficiently clear that there can be no such thing as a *single* best breed of cows for all localities, or even for several localities that are considerably different in climate, or in quality and quantity of feed, extent of exposure, etc.

In cold climates, with much exposure, thick skins and coats, with much activity, are required and developed; hence small but muscular breeds are most suitable. And this is true of all high altitudes where feed and natural protection are scanty. In localities of medium altitude, with only moderate feed supply, middle-sized muscular cattle are most consistent and suitable, while for rich bottom lands, with abundant feed, large cattle are well adapted; the principle to be kept in view in choosing a breed for any locality or purpose being, to select such cattle as will undergo the LEAST CHANGE by transfer from one country or locality to another.

When there must be, as is usual, some change, it should be *to more favorable* conditions, as deterioration follows change to inferior conditions, of feed particularly. Hence it is always safer to select hardy, active cattle for localities where activity and exposure are necessary incidents in cattle raising.

CHAPTER XIV.

IMMATURITY; OR TOO EARLY FATTENING AND BREEDING.

Inferior Quality and Food Value in Steers that are not Matured.

Many changes or alleged improvements in breeding and fattening cattle have been made within the last twenty years, changes in colors of Short-horns from white, and roan to red; then back to roan and white, for instance. But the marked characteristic which has been accelerated more in Short-horn cattle than in any other breed, is the fat-forming tendency, which has been increased to such a preponderating extent, that the muscular parts of these cattle have been much reduced, the greatly augmented quantity of fat having taken the place of much of their muscular structure, the reduction of muscle making place for the augmented proportion of fat. In fact, the natural activity of many Short-horns has been so much reduced, by *restricted* exercise, or confinement, that their natural proportion of muscle has been wasted or reduced to as much as 30 per cent *less* than the natural proportion that regular daily activity, and on average pasture, would maintain. This result has been produced, mainly, by these cattle being supplied with rich feed in great abundance, which has encouraged indolence and inactivity, thereby wasting muscle by disuse. Huge results in fat are attractive, but nutritive food-value is diminished to the same extent that muscle is thus reduced.

With the vast increase that is being made in numbers of cattle, and other stock, questions of food-value and meat quality become more prominent and important from day to day, and amongst others, the problem of early maturity or producing mature size at an immature age, or in half the time, arises. We say at an immature age, because this prematurity takes place without any change of climate, a warmer climate naturally leading to earlier maturity, as well as to earlier decay, in vegetation or in animals.

It is stated that an improved system of feeding* has produced a full mouth, in some cattle, at two years of age; why not, therefore, fit the heifers for maturity at that age? etc. When young cattle are so fed as to increase their growth very rapidly, the bones and muscle are usually more soft, and spongy in texture, and quality; as is the case with rapidly grown wood, which is only loosely coherent in its fibre, and decays rapidly; and the structure of flesh that is very rapidly formed in cattle, doubtless decays early and rapidly, according to the rule, "early ripe, early rotten." Muscle that is rapidly formed is usually loose in texture, and weak in contractile power. Hence the muscles concerned in the series of digestive processes are weaker, and the secreting organs, also; thus weakening digestive power in its foundations, by reducing the healthy proportion of muscle.

Some years ago, four or five mowings of grass were cut on land that was irrigated with the city sewage, at Edinburgh, Scotland; milk cows were fed with that rank, rapidly-grown grass, but the milk was so badly flavored and inferior, that the extent of mowing and the rapidity of growth in the grass were reduced, to improve the quality of the grass. The over-supply of sap to the cells was so great in the grass, that assimilation was too rapid to admit of the full extent of cell action that is required to form a sound quality of grass growth. In that cool climate natural growth is slow. Forcing grass to grow at more

* In Country Gentleman, February 5, 1880, p. 90.

than a double rate, was equivalent to requiring full and complete work in only half time. In fact, the grass was inferior in quality because too rapidly grown.

In young calves, fatted for veal, the few weeks allowed for their growth is so short a period that the cells have not time to thicken their walls, or consolidate their contents into mature, permanent structure. The process of tissue change is incomplete from a deficient supply of oxygen, as shown by the pale color of veal flesh; much of the watery portion of the calf's blood remains in the cells, causing the insipid and immature quality in veal. But, if enough time be allowed, this watery quality in the cells in veal is changed by internal cell-work, which gradually consolidates and matures the growth by a slow, but incessant process of change, until at mature age, crude and unnecessary ingredients have been eliminated by long-continued cell action; and the flesh becomes firm in texture, and mature in quality. But, of course, a pure, sound quality of flesh can only be formed from good, sound feed and blood, chiefly during regular activity.

In feeding steers for beef, so as to produce rapid increase in weight, under confinement, there is much nutritive material wasted, because it cannot be digested; digestive power, which depends upon muscular action to a considerable extent, being also weakened, as the muscular structure, generally, is reduced by confinement. Solvent digestion is similarly reduced, the secretion of the digestive juices being lessened in like proportion, as the muscular power is weakened.

It is evident, then, that digestion is not increased by merely increasing the food of confined cattle, nor is there any sufficient reason why digestion should be expected to take place at a rate that is 25 to 50 per cent more rapid than the rate that produces the best quality of animal growth.

On the contrary, a given quantity of food is digested more completely and thoroughly, when it is digested slowly, and more weight and growth of nutritive flesh is formed from a given amount of food by *slow feeding*, than by rapid cramming, or over-feeding. Hence there is a saving of feed that is equivalent to profit, from slow or gradual fattening for beef.

Yet the fact that fattening cattle gain in weight less rapidly during the third than the second year, and during the fourth than the third year, when slowly fed until four years old, has been made a plea for fattening at an early age. But, as shrewd feeders have told us, and we have observed for over forty years, much less feed is required, in the same length of time, to finish off cattle that are already half fattened, than is required to make them half fat.

The interstices where fat is usually first stored, are already filled with fat, before much is stored or shows itself immediately under the skin; while the muscles are already considerably reduced in cattle that have been confined some time, there being also a reduction in the quantity of blood, and rate of assimilation.

The appetite becomes cloyed and reduced, the demand for food and the cost of feeding being less, while the quality of flesh that is only slowly formed is clear-grained, sounder, and more nutritive. In fact, slow fattening prevents waste of nutriment in the droppings; the notion that inactive cattle have digestive power according to any quantity of food supplied, being "an illusion," for the process of maturing growth in cattle can be only *half performed* in *half time*.

The inferior quality of swill-fed pork is a familiar instance of poor meat quality from over-rapid feeding. The quality of the fat in swill-fed pork is so soft and unstable, that much of it "boils away" in cooking; the heat of the water melting the soft fat-cells into a poor quality of oil, instead of the fat remaining solid while the meat is cooking.

Evidently the rapid feeding does not improve meat quality, the fat being increased by reduction of muscle and nutritive value under confinement. But exercise while fattening* saves muscle, insuring good quality in meat, which is improved feeding, because it improves meat quality.

Muscle being the basis of food-value in meat, food-value gradually increases, when exercise is ample, as in the Western herds† for instance, until the growth be complete, at mature age. By too early fattening this important source of increase in muscle and food is ignored, and cut off, causing great loss.

Colts are allowed by many good horse breeders to mature only slowly, having ample exercise, with but little or no grain, because they make more enduring growth without, than with rich food; and heifers require time, and exercise to develop muscle and capacity for digestion, breeding, and milk-yield, as colts do to give them power for activity and work.

The Channel Island cattle breed early, but these lawn cattle are lighter in their muscles than any other breed, from having been tethered or tied from time immemorial. The proteids of the food go, in large degree, in such cases through the udder to the pail. Having but little muscle to mature, but little blood and time are required in forming their muscular structure. Hence the slender muscles of the breed are formed with but little material at an early age, in that mild climate. The muscular growth being only slender and completed early, a sufficient surplus of breeding blood remains to give rise to coupling, and breeding at an early age. So the light muscular growth

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* See Country Gentleman, February 12, 1880, p. 106, Mr. Gillette's Improved Feeding.

† We have seen this result in Western Iowa, where we have a small, but good stock-farm.

of the Jerseys and Guernseys is formed in much less time than, at the *same rate* of nutrition, would be required if their muscular structure were much larger in extent, as is shown in the much more muscular, and later maturing Devon cattle.

The tendency to breed and fatten at an early age was, however, most noticed and encouraged in families or herds of the more widely known Short-horns. Many cattle of this breed have long been slender in their muscular structure, as the result of reduced activity, from over-liberal feeding. Thus many Short-horns breed early from their slender muscular growth being early completed, because it is slender; much proteid material, that would be required in forming large muscular systems, going to form fat, in these large, but slender-muscled cattle. Hence, at the *same rate* of nutrition, the slender muscular structure of many Short-horns is formed at an early age, and in much less time, than is required in forming larger muscular proportion, as in muscular breeds like the Galloways and Devons. So the slender muscles of many Short-horns are early formed, according to their reduced extent; this being an influential cause of the early breeding as well as early fattening of many Short-horn cattle.

According to the highest authority,* rapid cell-changes and growth are imperfect, and liable to early decay, while the best quality and most enduring structure in animal growth, is only slowly formed. The less time there is for eliminating action in the cells, the more crude and immature the structures formed by imperfect assimilation must be.

The insipid flavor, loose structure, and innutritive quality of veal are well known. A deficiency of oxygen is indicated by the pale color of the veal, tied-up calves breathing but little air, no time being allowed for maturing, as

* Dr. L. S. Beale, Physi. Anat., Part II.

that is not expected. But the loose structure and immature quality of veal serve for contrast with the quality of mature, fine-grained, juicy beef.

Two-year-old beef is about midway in quality between insipid veal and fully matured beef. There is not time for large or full muscles, or perfect structure, to develop, while inactivity under confinement retards the rate of cell changes, preventing the growth of muscle. So two-year-old beef is too beefy to be classed as veal, while too vealy to be classed as mature beef; fattening at this early age producing an inferior bulk rather than a prime quality of beef-food.

It is a misnomer to call two-year-old steers or heifers mature, merely because they are large in size; over-rapid growth in vegetable or animal fabrics being inferior in quality; for there is not time for the necessary extent of cell changes, that produce superior quality, to take place. Hence fattening and breeding at two years old prevents a large development of muscle and its food value in steers, and growth in heifers, by arresting the maturing process, when the muscular parts—that contain the food-value—are comparatively soft and tender; the result being "big veal"* instead of mature beef.

Too early breeding, at under two years by heifers, tends to dwarf their size, to impair their constitutional vigor, and to reduce the size of their calves, which are, or should be, the basement-story of full-sized cows. Thus, while there is emulation almost amounting to extravagance, in striving for large yields of milk, there seems to be unthinking emulation in reducing the size, and digestive power, which is the basis of large yield, while size and digestive power are necessary to good breeding capacity; and early breeding undoubtedly tends to early decay.

The time for mature quality is at mature age; the ex-

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* See Country Gentleman, p. 122, Feb. 19, 1880.

tent of time having been naturally established in the process of developing full growth and mature quality together. The juicy qualities and nutritive value of beef being contained in its muscular or fleshy parts, a greater quantity of nutritive meat, that is, better in quality, is produced by keeping fattening-steers till mature age, increasing the weight and value, without increasing the number; moderate exercise while fattening preventing waste of muscle, and so maintaining the best qualities and fullest extent of food-value in the meat, which is the legitimate and beneficial object in producing beef food.

CHAPTER XV.

Bulk in Cattle Feed; and Digestion.

Influences of Bulk on the Body and the Lungs.

Between the years 1875 and 1879, a few farmers in New York restricted their dry cows exclusively to corn-meal rations during the winter, without unfavorable results becoming apparent in so short a period. But if no unfavorable results appeared from temporary and quite limited trials of concentrated food exclusively, such a reduction in the ordinary and natural bulk of food consumed, must, if long continued, lead to both internal and external changes that could not be beneficial either to animal or owner.

Bulk of food *is* necessary to maintain the natural size and proportion in the salivary glands, in the stomach, and in the bowels, and in all parts of the alimentary canal.

It is the difference in bulk of food—long-continued—that causes the difference in the size of the bowels in the race-horse, compared with heavy farm-horses; the English cart-horse presenting, in his full size under the loins, a strong contrast to the tucked-up form and lighter weight of the race-horse, or to the arched back and light, tucked-up loins of the Greyhound dog. And, whatever may be desirable as to light weight in the bowels of fast horses, and fleeter dogs, it is not requisite that work horses, and breeding or milk cows, or other cattle, should be either light in the bowels or small in the stomach, as much of the feed which can generally be supplied to either horses or to cattle, at any season, is coarse and bulky. Moreover, bulky feed gives fuller size in the abdomen, which supplies space for circulation, and for embryonic breeding, as well as an increased extent of surface and size in the beef cuts that are most in demand.

Size, and the weight it supplies, are also important in draft horses, that move *heavy* loads forward, with success in proportion to their weight, as well as to their muscular power, their greater weight, in leaning forward, helping to propel or draw the load, at the same time holding the animal firmer to the ground by gravitation, while muscular force, also, is being exerted by contractive motion.

But a little further as to cattle: —

Much of the power exerted in digestion is mechanical, or from movements in the muscular parts and organs during the successive stages of digestion. In the mouth, the supply of salivary juice is not only according to active motion, but also to the size of salivary glands. And the mixing of the saliva with the masticated food is much facilitated by a mixture of divisory or bulky parts in the crude feed. In the stomach it is necessary that the coats of the organ come in contact with the surface of the mass it contains, to keep it revolving by peristaltic motion, thus bringing different parts of the mass, successively, in contact with the parts that discharge the gastric juice, the size of the stomach and the extent of its surface discharging this solvent fluid both being increased according to increase in bulk of feed, this rule applying up to the natural proportion of bulk to nutriment that is supplied in grass or hay. The same is true of the influence of bulk in maintaining natural size — the size that has been developed by and according to bulk in the natural food—in the small and large intestines or bowels. In fact, natural bulk formed by the proportions of digestible and indigestible food together, is required to maintain the necessary size in all the digestive organs; and bulk in feed has undoubtedly much influence in continually maintaining size in the body itself, when there is sufficient digestive aliment in the food to renew and maintain the vital tissues. Indeed, the size and bulk of the lungs, heart, stomach, and bowels, constitute a continuous mold, around which the body grows; the form, and particularly the *size* of the body, being much influenced by the form and *size* of the lungs and alimentary organs that supply the mechanical influence of an interior mold, that exerts much effect on the exterior growth and size of the body.

In the solvent processes of digestion, occurring during the forward movement by muscular force of the mass of pabulum containing digestible material, the penetration of the gastric juice into the mass, while in the stomach, is much easier and more thorough than would be possible if the stomach were reduced to half or a third of its natural size, by reducing the bulk of food in that or similar proportion. And the same holds true of the bowels, where considerable digestive action takes place. In either of these organs the indigestible parts of naturally proportioned food serve as a divisor, making the mass more permeable, and its digestible parts more readily accessible to the solvent juices in each stage of digestion, in the stomach as well as in the bowels; bulk, in fact, being equally necessary in the stomach and continuous parts of the entire digestive or alimentary canal.

The principle reason why Graham bread is much used by dyspeptics and others, is, that it is far more easily digested, because more permeable to the digestive juices, from containing the natural *bulk* and proportion of expansive and divisory ingredients, as well as the several different qualities of nutritive constituents, the mass being far more easily penetrated by digestive juices than an equal mass of fine-flour bread closely compacted in the stomach. We see, then, that bulk in food is very important in maintaining the size in the several digestive organs, and efficiency in their functions.

Bulk in food is evidently necessary also to maintain size and natural proportion in the organs, frame-work, and form of the body itself. For instance, the breathing power would be reduced according to any reduction in the size of the lungs; and in the structure of the lungs, the *size* of the *air cells* is increased and maintained by the large proportion of nitrogen in the air breathed; the nitrogen serving as diffused and expansive filling, amongst which the oxygen freely circulates, the larger bulk of nitrogen maintaining the full natural size in the cells of the breathing organs.

The same is true of the crude, innutritive portions of the blood, which comprise over half its bulk. If all parts of the blood were naturally nutritive, and used for nutrition, a condition of emptiness in the blood-vessels would follow; but this is neither natural nor necessary. On the contrary, it is both natural and necessary that a large portion of the blood should be innutritive, the innutritive part being mechanically necessary to keep the blood-vessels—the arteries, particularly—expanded to their ordinary and natural size, as we find them in our farm animals.

In the body, or its external surface, the breadth or width of the back across the loins and of the hips is usually according to the size of the abdominal region. And how, it may be asked, could size in the millions of cattle mainly subsisting on grass and hay, be maintained otherwise than by the expansive influence of natural bulk in their feed?

The truth is, that the frame-work and flesh growth of the animal is formed around the lungs, and the digestive organs that comprise the alimentary canal, and that the extent of flesh-growth and size of frame-work is largely dependent upon the size of the mold around which they grow, which, in this case, is according to bulk in its various contents. Hence it is not necessary to further insist on the evident influence of bulk in the air inhaled by the lungs to maintain the natural size of their cells, and of the whole breathing organ; and in maintaining due size in the digestive organs and surrounding growth of cattle and other domestic animals, this being most conspicuously necessary in cattle, sheep, and horses.

If concentrated food were substituted for the natural proportion of bulky fodder in feeding growing calves, heifers, and steers, from their first use of natural provender, their stomach and entire alimentary canal would necessarily contract to the small bulk of their contents. The natural size of the body would be thus reduced, and animals so fed would soon present the tucked-up appearance of the race horse or Greyhound, thus changing their natural form, as well as reducing the size of cattle. Or, if they were grass-fed in summer and meal-fed in winter, the alimentary canal would be contracted in one season and expanded in the other, according to the change in the bulk of the feed, a result that is equally unnatural and unnecessary. If young growing stock were fed in this way until the age of maturity, their size would be considerably reduced by such unnaturally concentrated feeding.

If the practice be recommended for cows because no injurious consequences appear in the short period of a few months, that is no justification of a practice that cannot generally be carried out, because of its inconsistency with the necessary bulk that is required to facilitate digestion, as well as to maintain size in the successive parts of the alimentary canal; as one, and by no means an unimportant, condition that is essential in maintaining the natural size in the animals, due proportion in bulk as well as nutriment being required in feed to produce the best permanent results in feeding any class of farm animals; and while considerable bulk in feed is necessary to give the natural proportion or size of parts in growing animals, for the reasons advanced, bulk in feed, air, and blood become a permanent necessity to maintain size in the body, in the lungs, and in the entire system of the blood-vessels that convey alimentary matters to all parts of the body structure.

CHAPTER XVI.

Lung Plague in Cattle, and Cholera in Hogs.

The Conditions leading to the Origin of these Diseases.

That some cattle are susceptible to diseases of the lungs in consequence of changed conditions in themselves and in their surroundings, is well known; and that they are more susceptible to lung diseases, the further their necessary conditions of breathing are unfavorably changed, is indisputable. Oxygen is the leading necessary of life to all breathing, locomoting animals; and this is conspicuously true of such farm stock as cattle and swine, a fact with which practical farmers are familiar.

A leading natural condition of cattle and swine, is constant out-door activity in gathering their daily food. This regular out-door activity increases the supply of oxygen in the blood; and the rate of breathing and extent or quantity of oxygen in the blood, which daily out-door exercise causes and supplies, is the necessary or natural rate and extent of breathing, which completes and supplies the necessary quantity and proportion of oxygenated blood conveyed by the arteries.

Breathing completes the blood, by suppyling the oxygen which causes all the red blood to circulate. So the quantity of blood that circulates, is made to circulate by its oxygen, and the extent of the blood circulation corresponds with the extent of breathing; which latter—when above the minimum of inaction—is according to the extent of out-door exercise.

That the out-door exercise of many thousands of cows in Europe and America has been much restricted, reduced, or prohibited, by confinement, or housing, is notorious and obvious to all who choose to observe it.

Probably the reduction in the natural activity of cows from greatly reducing their out-door exercise in many thousands of cases, both in Europe and America, and nearly prohibiting out-door activity of many more thousands of cows on both continents, has reduced the natural activity of these great numbers of cows on both continents, to as much as 70 per cent less than their natural degree and extent of out-door exercise.

The extent of breathing, beyond the inactive minimum, is increased according to the natural extent of out-door exercise; the natural extent of breathing being that degree which is induced in gathering food by regular grazing. So that when this multitude of cows are confined and fed in stalls, or in small pens, their *breathing is reduced* to the inactive minimum; which is probably 35 or 40 per cent less than the healthy and natural extent. In this way, the natural quantity of oxygen in the blood is reduced to about 40 per cent below the necessary and healthful extent of oxygenated and completed blood.

That millions of hogs,* particularly in the extensive corn regions of the West, have had their muscle reduced, and their fat, and resulting *in*activity correspondingly increased, is a very evident and well-known fact in the leading States west of Pennsylvania. The proportion of fat in millions of western bred hogs has been so much increased within twenty-five years, that their muscle and bone have been reduced to a mere minimum; their reduced activity being carried so far, that vast numbers of them pass from three-fourths to nine-tenths of their lives, after the first three months, in the slow-breathing state of inactive repose.

* See reduction of muscle and food-value in Cattle and Swine, Chapter XVII.

Their natural degree of activity has been reduced more than 70 per cent, and their extent of breathing has probably been reduced to the extent of 40 per cent below the natural extent that hogs engaged in daily out-door grazing, breathe during their natural exercise.

It is this reduction in the natural and healthy extent of daily exercise, and the corresponding reduction in the healthy extent of breathing, that constitutes the unfavorably changed conditions of very many inactive cows—including some other cattle, in both Europe and this country; and in millions of over-fat and under-exercised hogs, in considerable parts of the United States.

The *reduction* of exercise and breathing in these cows is probably 33 per cent of the natural quantity of oxygen, which full breathing supplies to complete the red blood corpuscles. And, as breathing is a dual and reciprocating process, the extent of exhalatory breathing by the lungs—whose function it is to carry excretory poisons from the blood—is reduced some 33 per cent below the natural and healthy extent of excretory breathing.

Cattle and hogs naturally require considerable rest, during which rumination and sleep take place. The repose occurs principally in the night time; but whenever it occurs the rate of circulation and nutrition are retarded, by diminished muscular motion, and reduced breathing; the rate of exhalation by the lungs being similarly reduced. During a condition of repose, the poison, carbonic acid, is constantly passing from the tissues into the venous blood in cattle and swine; so that an accumulation of this poison in the blood during long periods of repose, takes place. Both during repose and activity, this discharge of poison into the venous blood goes on from the muscles, and other tissues. The discharge of carbonic acid poison from the muscles is increasing, and extensive, and the amount of this poison formed in the system during repose, probably occasions a considerable increase of excretory matter in the blood* during each considerable period of indolent inaction or quietude.

The natural provision, and only efficient means, for expelling this accumulated excretory matter from the body is by active exhalatory breathing, which is accelerated by regular exercise, mainly in the day-time, or between the periods of quietude. Only by such daily activity in body and breathing can the excess of poison that accumulates during considerable periods of inaction, be worked off by increased daily exhalation through the lungs, and for this necessary purpose, to increase respiration in the day-time, as much as, or more than expiration is reduced during periods of inaction, or of rest or sleep, for the purpose of expelling excretory matters from the blood, increased activity and breathing becomes an evident necessity, to insure in creased exhalation, and the discharge of any accumulated† excretory matters from the blood, as it courses through the lungs. So regular out-door exercise is an evident daily necessity, as the only means of increasing respiration, thus increasing excretory action, and the supply of oxygen in the artery blood by breathing, at the same time, in corresponding degree.

The increased supply of oxygen in the blood, from active exercise and breathing, increases the quantity of oxygen in the tissues, which is drawn upon in constantly forming carbonic acid‡ during assimilation.

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* Although the urea and the excretory matter passing off through the skin add, by retention, to accumulated excretory matter in the blood, we restrict our remarks to excretion by way of the lungs, to give more emphasis and point, as nine-tenths of the poison retained in the blood would pass off through the lungs, if sufficient exercise were permitted or enforced.

† "The products of decay not being carried off as fast as they are formed, and not being converted into readily soluble substances, *accumulate*, and seriously interfere with the tissue already formed. As frequently happens, * * certain *excrementitious* compounds, which ought to have been entirely eliminated, remain in the fluid," etc.—Beale's Physiological Anatomy, p. 155.

‡ Respiratory breathing is the ultimate cause of the blood continuing to flow or circulate. For, although the production of carbonic acid in the tissues demands a constant supply of oxygen to replace that which passes from

By the prevalent custom of tying-up, penning, and in this and other ways *preventing* the necessary exercise of cattle, particularly that of cows, in Germany and Russia, and parts of England, and in several American localities, particularly in the vicinity of New York, Philadelphia, and other large populations, much of the necessary daily extent of excretory breathing is prevented, and the accumulated poison in the blood, so far from being reduced in the day-time, is augmented, while constant additions to this poison in the blood are made, as the result of a reduced extent of breathing during the daily periods of repose, when activity is urgently necessary to restore a healthy balance and quality of blood, by the cows and hogs, by maintaining a healthy extent of excretion from their foul blood.

In consequence of a too small quantity of oxygen in the blood from reduced exercise and diminished breathing, the proportion of carbonic acid increases in all parts of the venous circulation, including the lungs. So the natural balance of oxygen with other blood-constituents is destroyed, the quantity and proportion of oxygen being gradually, or rapidly, reduced, while the excess of carbonic acid is as rapidly and continually increased.

The increase of poison thus accumulated severely irritates the lungs, because they receive and pass such a vast

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the tissues into the venous blood as an ingredient of carbonic acid, this demand for oxygen does not reduce the quantity or bulk of the blood. But expiratory breathing *reduces* the bulk of the blood as much and as continuously as inspiratory breathing increases its quantity, by introducing the oxygen that adds to its bulk and completes the blood by supplying vital oxygen to complete its red corpuscles. Expiration empties space, thus making place for the increase of bulk which inhaled oxygen causes. Hence by reducing the bulk of blood, so creating a comparative vacuum, expiratory breathing makes space for the inhaled oxygen, so making the flow or circulation of the blood possible and necessary to fill the space continuously vacated by the carbonic acid expired. Motion in the contents of the red and white corpuscles of the blood is caused by pulsation, and the continual change in the position of the cell-contents, from their rolling motion in the liquid portion of the blood. The constant change in the relative positions of the corpuscles causes an equally incessant change in the position of the cell contents—the change of the position in the cell elements continually leading to new chemical action. So the pulse motion gives rise to change mechanically, which leads to new and increasing chemical change, by which the ultimate process of assimilation and tissue formation are effected.

quantity of this morbid quality of blood. This increase of carbonaceous and animal poisons in the blood thickens it, making its circulation more slow and difficult than is natural or healthy.

The animal matter expired by breathing, is stated on good authority to be an "active and dangerous poison." * It seems that two hundred out of three hundred soldiers were poisoned in a few hours, by breathing over such expired poison, in a cavern they were confined in, after the battle of Austerlitz. And so poisonous is carbonic acid known to be, that formerly suicides poisoned themselves by inhaling carbonic acid, set free by burning charcoal near the floor, in close unventilated rooms. The poisonous nature of retained excretions is, however, now so well understood that the danger of inhaling such matter is fully recognized, as to the *human* subject, and—let us add—as to *horses* also, as the latter have plenty of exercise and breathing.

The blood becomes more loaded with excretory poisonous matter from every reduction of oxygen, carbonic acid taking the place that oxygen should occupy.

As cows become larger producers of milk, they are usually more closely confined, many of them breathing over expired air that contains excretory poisons, in considerable quantity. And this increase of excretory matter in the blood continues, until at length the blood becomes so overloaded with these poisonous matters that it irritates, and thus weakens the membranes of the lungs. The lungs are the natural outlet of this poison, being traversed by this morbid blood in vast quantity, therefore the lungs are more liable to iritation and injury by poisoned blood than any other organ.

To show the danger which cows that are confined in badly ventilated stables, and over-fat hogs that huddle together in crowds, are exposed to, in breathing over any

* See Hutchinson's Physi., p. 136 to 140.

portion of their expirations: it is known that a man exhales half a cubic foot of carbonic acid *per hour* when still, while a confined cow, of average size, exhales five times as much. And huddling, inactive, indolent hogs probably exhale twice as much per hour to each 300 lbs. of their weight. Captive wild animals, that are closely confined, many of them soon die of consumption, because their activity of breathing, and oxygen supply, are so much reduced by confinement.

The great over-proportion of excretory matter in the blood of inactive cattle or hogs, makes it so poisonous after some time, that sound, healthy tissue can no longer be formed from such a bad quality of blood. The lungs of the cows being irritated, and the air-cells probably being reduced in size by irritation of the lung membranes, some of this excretory matter, carried in by the venous blood, gets entangled, and lodges in the air-cells of the lungs. A nucleus being thus formed, the quantity of excretory matter in the air-cells, in parts of the lungs, is rapidly increased by affinitive attraction, and consolidated by the chemical cohesion that succeeds. In this way parts of the lungs in cows become more or less rapidly solidified, the breathing capacity of the lungs being thereby proportionately reduced. The size of the air-cells throughout the entire structure of the lungs is probably reduced by inflammatory irritation and swelling at the same time. And in a little while after this accretion of poisonous matters has filled the cells in parts of the lungs, this cause, and the great irritation throughout the organ, reduces the breathing capacity so rapidly and so much, that the affected animal dies of suffocation.

This result is due immediately to a deficient supply of oxygen, the deficiency of oxygen being caused by long-reduced or much prohibited exercise.

Cows may also die from gradually-increasing inflammation, reducing the size of the lung-cells by the irritating excess of carbonic acid and poisonous animal matters, thus having their breathing capacity diminished, until the stage of suffocation is reached.

In either of the above cases, the certain primary cause of a deficient supply and reduced proportion of oxygen in the circulation, arises from the close and long-continued confinement of cows, in most instances in which lung-plague occurs.*

When lung-plague becomes contagious, it is because Bacteria or other scavenger or fungoid growths, mature in the poisoned blood, the result being that spores are exhaled by affected cows, and inhaled by others that breathe exhaled air containing spores; whether the cattle that inhale the spores be predisposed by poisoned blood or not.

There is but little danger of lung-plague when a fair extent of out-door exercise and breathing keep the blood pure. But when the circulation is surcharged with excretory poisons, as usually happens to inactive cows that breathe but little oxygen, while taking but little exercise, the danger arising from inactivity and retained poison in the blood is much augmented. In fact, the danger of infection and contagion is increased in proportion to the excess of excretory poisons that are *un*necessarily retained in the blood; the poisoning of the blood in such cases arising from the exercise and breathing having been reduced to a much less extent than is necessary to maintain the sound quality of blood and the sound health that result from regular daily exercise, which causes active breathing and a healthy supply of oxygen in the circulation.

When hogs are fed almost exclusively with corn or corn-meal, their blood becomes over-loaded with carbonaceous

* We believe that the blood of cattle that are affected severely with lung fevers, either acute or long-continued, is over-charged with excretory poisons; and that a large majority of cows or other cattle that are affected with Rhinderpest are by far too much restricted in their exercise and breathing.

excretory matters, at amore *rapid* rate than happens with cows that are supplied with less oily feed. And hogs in the great corn districts, where hog cholera chiefly prevails, are so fed in nearly all cases.

From huddling together in crowds, hogs in contact with one another incidentally breathe over much of the expired breath, with its contained carbonic acid, and other poison. In this way, many hogs together become affected with blood poison, at the same time, and in the same herds. So the blood of a whole herd of hogs may thus become loaded with an excess of excretory matter; for, though not tied up, the over-fat hogs on very many leading corn farms, are inactive, breathing but little during from three-quarters to nine-tenths of their lives, after they are ten weeks old. From the carbonaceous quality of their food, their inactive habits, and their inhaling already poisoned air, the blood of the hogs in many herds soon becomes over-charged with poison, and too deficient in oxygen to form healthy flesh, or growth, or to renew even the small extent of living muscle which remains from the much-reduced exercise.

There are peculiarities in the bodily condition of hogs that account for their intestines being much more affected than their lungs by the fever of hog cholera; while the lungs appear less injured than those of lung-diseased cows or other cattle. Over-fat hogs have a wall of fat extending around their bowels, and surrounding the entire alimentary canal. Within this wall of fat much heat is closely imprisoned, as it were.

Huddling together in crowds, hogs share their skin-heat to a large extent; this position also intensifying the internal heat, particularly in the intestines, where the high degree of heat probably induces fermentation in the fecal matters. So the higher degree of heat in the intestines of over-fat hogs, accounts for the lesser degree of injury in their lungs, compared with those of cows that are affected with lung fever.

The fermentation in the fecal matter in the swine affected with the cholera, also explains the lacerated condition, and sloughing or detachment of the epithelial lining of the intestines, in some cases of hog cholera.

The blood of affected hogs becoming very poisonous from the excess of excretory matter retained in it, Bacteria appear, and begin to grow and multiply in number. But why do the Bacteria grow and multiply in poisoned blood, while parasites feed on sound or unpoisoned blood? The consistent answer is: Because the Bacteria are scavenger organisms, whose mission and function it is to organize blood poison—and probably other poisons—and to grow and multiply by organizing poisoned blood material. The parasite feeds on sound blood, the scavenger Bacteria organize poisoned blood. Such is the evident difference and distinction between the natures of the two, and what each feeds upon and grows with.

Swine that have only a little poison in their blood, recover when Bacteria no longer multiply, because there is no dangerous quantity of poison remaining in the blood for them to organize or grow with.

We see fungoid growths forming from decomposing matter in manure heaps and pastures; which suggests that Bacteria are probably of a fungoid nature. But whether they are animal, or vegetable, or hybrid in nature, is not material, the bad quality of blood, which induces Bacteria to invade the circulation, being the material cause of the trouble or cholera.

As there is reason to believe that Bacteria usually appear *only* in poisoned blood—not invading blood of good quality—it can make no practical difference to breeders of hogs, whether the Bacteria are vegetable or animal organisms, or when, or where the spores originate, so long as the spores do not invade the blood, unless it be bad in quality, from containing an accumulated excess of carbonic acid, and animal matters that are poisonous.

The only way to *prevent* hogs taking Bacteria, or becoming affected with cholera, is to keep their blood healthy, with a full supply and proportion of oxygen from full breathing. This can readily be done by allowing or compelling the hogs to take sufficient regular exercise* daily, to insure a sufficient extent in breathing, and a healthy supply of oxygenated blood that is sound; the Bacteria not invading sound blood, because they grow only by feeding on poisonous matters.

Increased activity increases thirst also, causing more water to pass through the system, which, besides serving detergent purposes, thins and cools the blood, so conducing to maintain its proper fluidity and temperature.

When the healthy proportion of oxygen is reduced by reducing exercise, the quantity of excretory matters gradually or rapidly increases until it becomes excessive, when it furnishes a *nidus*, or breeding bed, of such a poisonous and dangerous character that Bacteria appear to organize this blood poison, because it is their natural aliment, and their proper function to organize such bad qualities of matter, or feed upon blood-poison, which, however, would not be present in diseasing excess, if the necessary extent of exhalatory breathing were not absurdly and injuriously reduced or prevented by reduced or prevented exercise.

As will be readily inferred, hogs that have their blood invaded or infected with Bacteria, may recover when there is but little excretory poison in their blood. But when the accumulated poison becomes excessive in extent, hogs do not usually survive the invasion of scavenger Bacteria,

* Habitual excerise is the cause and condition of that vital renovation of parts which is the source and measure of *constitutional vigor*. Huxley and Youmans' Physi., p. 422.

because there is not enough sound blood left to carry on the vital functions.

Exercise on high ground may mitigate the hog-cholera trouble, by increasing the extent of exhalation, so relieving the blood in some degree of the accumulated poisons.* Regular daily exercise in good-sized pastures, or in open grounds—of which there are many instances in Michigan and elsewhere—together with a greater variety and more albuminous quality of feed, is the only safe preventive treatment that can reasonably be expected to exempt swine from the invasion of Bacteria. Keep the blood of the hogs sound by a healthy supply of oxygen from regular exercise and full breathing, and Bacteria or cholera, will not affect the hogs, nor vex their owners. And the only sure preventive of lung-plague, Rhinderpest, or lung fevers in cows, or other cattle, is regular, moderate exercise in wholesome air, thus cooling the circulation, while supplying a healthy proportion of oxygenated blood, that will *not* irritate the lungs, while such a quality of blood certainly forms sound tissue, in renewing general growth, or in enlarging size in growing cattle or swine.

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* Probably, fermentive changes, in retained excretory matter, under a high temperature of the blood, in some parts of the circulation, originate the dangerous and peculiar blood poisons which the scavenger Bacteria organize. Certainly, the only way to prevent fermentive action in the blood, and the formation of dangerous poisons in the circulation, is to maintain efficient activity of exhalation by sufficient and regular out-door exercise, both by cattle and swine. The blood is cooled by increased breathing, with a proper supply of water also, while dangerous matters are reduced by increased excretion, from active exercise in pure air. Some years ago we saw a report of an experiment in Paris. Venous blood taken from the human veins was allowed to stand and ferment sixty hours in a vessel. By this time it became so virulent a poison that when two teaspoonfuls were administered to a dog, the dog died in two hours afterwards, which shows the danger of increased poison in the blood. The writer of this work accidentally inhaled a considerable quantity of carbonic acid, set free from charcoal used in drying hops, in the year 1853; the result being violent shaking with ague, caused by this poison in the blood, every day for fifty-nine days without intermission. We have reliable authority for stating that a man in Carroll county, Iowa, in killing a hog affected with the cholera disease, had a large drop of the hog's blood fall on his hand, the effect of which was so painful, quickly after, that he had to burn the poisoned spot off the skin with a hot iron, to stop the pain and prevent the poison spreading.

CHAPTER XVII.

Loss of Muscle in Cattle and Hogs,

And the Loss in Food Value, and Money Value from Loss of Muscle.

The flow of blood into muscular parts of cattle takes place when the length of the muscles is contracted, while the central parts are increased in thickness, and the supply of blood in the muscle-vessels is therefore generally according to the number of muscular contractions—giving rise to all the animal movements—the number of contractions being according to activity. Active exercise is therefore a necessity, to facilitate and insure circulation in, and nourishment of, the muscular parts of cattle. The muscles cannot be sufficiently nourished without the motion which exercise causes; hence the nourishment, growth, renewal, and strength of the muscles, beyond the slender minimum, each and all depend upon, and are increased and maintained by, regular out-door exercise in conjunction with food.

Foster, in his able Text-Book on Physiology, Page 65, says: "When muscle within the body is unused, it wastes; when used moderately, muscle grows. Both these facts show that the nutrition of muscle is favorably affected by its functional activity."

Muscle wastes by disuse, because its contractions cease with inaction, and the blood no longer flows to the muscular fibres when they no longer contract. So muscles die by inaction and disorganization, for want of motion and blood. And muscles grow from increased exercise, the number and extent of contractions—which give rise to all motion in animals—and the supply of blood to the muscles while contracted, increase, according to the increase in exercise by cattle, horses, or swine.

In the marmot and other hibernating animals, the blood heat is reduced nearly as low as the temperature of the surrounding air, the rate of breathing being reduced from five hundred to fourteen beats in an hour,* while the rate of pulsation from the blood circulation is reduced from one hundred and fifty to fifteen beats per minute, which shows the effect of extremely reduced motion, or of almost total inaction in the locomotive organs. The slight interior motion, caused by the slow pulsation and breathing, comprising the sum of motion in the body of the marmot while hibernating, strongly contrasts with the active exercise and equally active breathing during exercise by cattle, or swine, or horses. And in the increase in breathing and blood, we have the source of increased nutrition and growth of muscle.

That the breathing of cattle is reduced some 40 per cent by tying, or any close confinement, during the five or six months of winter each year, is evident, and a reduction of 20 to 30 per cent in the blood and muscles of cattle so closely restricted in their exercise, appears reasonably certain. This reduction of red blood and muscle, or flesh, in store cattle of all ages, is very general, through the Middle and Northern States. The reduction of exercise correspondingly reduces the extent of muscular contraction, blood circulation, and nutrition, in the muscles; being thereby reduced according to the reduced extent of exercise. This is what happens to milk cows, in large numbers, that are closely confined; also, to store cattle of all kinds, that have their exercise reduced to the minimum extent during the comparatively still condition through

* Read Youmans' Chemistry, p. 445.

the long winter seasons. However much food may be given, the quantity of red or arterial blood is reduced in extent according to the various degrees of reduction in exercise, as the crude blood, such as is produced by digestive solution, but not oxygenated, cannot flow in the arteries, and does not therefore nourish the tissues or muscles till after it is completed by breathing.

Cattle of all breeds and grades, that are active through the entire grazing season, rapidly lose muscle or flesh, particularly in the muscles and parts that are made active by out-door exercise—*when* they come to be tied up, or confined in small yards. The activity of cattle in such cases is reduced 50 per cent, probably, on an average. They develop 30 to 40 per cent less heat in the tissues also, and have a greatly reduced general heat supply, because their activity and breathing, which develop latent heat into active warmth, are together so much reduced during such periods of close confinement.

All cattle that are much restricted in their natural and necessary activity,* lose muscle in a certain and large degree, corresponding with their reduced exercise, whether the reduced activity be compulsory, or results from increased tenderness, or from any other cause creating disinclination for, or preventing active motion.

The reduction of muscle in fattening cattle, when prohibited from exercise, is very considerable in extent, probably amounting to 30 per cent reduction or waste of their muscular flesh, and to some extent there is waste from fatty degeneration also.

Probably some 15,000,000, or nearly half the number of cattle in the American States and Territories, are raised East, but including the banks of the Mississippi River.

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*Inaction contravenes the natural use of the locomotive parts of the constitution, and is therefore adverse to health. "As bodily vigor results only from active and well-regulated exercise, the absence of such exercise must entail bodily debility."—Huxley's Physi., p. 426.

And the muscle of this number of cattle is probably reduced 25 per cent, *average* extent, during the winter season of each year. So, during the cold weather season, when most of them are inactive, nearly half the cattle of the country—many herds that have considerable exercise being excluded from such influence, of course—have their muscles and food-value reduced 25 per cent, which, calling the weight of the 15,000,000 cattle 100,000,000 pounds, amounts to twenty-five millions of pounds reduction of muscle and food-value every year in cattle, by prohibiting or diminishing their exercise, breathing, and circulation, and nutrition, by from 30 to 50 per cent, during the dry-feed season, yearly.

Twenty-five years ago the number of Land-Pike, or long-nosed, lank, and large-boned hogs, largely predominated over the numbers of all others. The Suffolk and China, and other fat-forming breeds, were introduced, together with the old-time Berkshires and the Essex breed. In a few years corn-growing and hog-raising followed or succeeded wheat-growing to the westward. Hogs were found very profitable, and a strong demand arose for *large* and easily-fatting hogs. Increase in the size of hogs, and in the extent of corn-growing, rapidly extended across the Mississippi, with an increased demand for size and fat in hogs. And this tendency to produce fat has been augmented in such enormous proportions that the leading corn-growing districts of the West—of which Iowa is the leading example—produce hogs that have been bred to the opposite extreme, in comparison with the old-time Land-Pike. From the flat-sided, lank forms, long noses, and large bones, millions of hogs in the leading corn districts of the West, have been changed till they have but little nose, and very small bones, with *not* half enough muscle for their proper health, or most nutritive food-value, left to them. The fat-forming tendency has increased till they are only lumps of lard.

The appearance of their dished faces and pug noses in many of these pseudo-improved hogs, indicates a reduced size of breathing-tubes through the face bones, with a reduced lung power and extent of breathing. And the size of their legs is so diminutive as to be out of all due proportion to their body-size and great weight; the weight of the hogs, in some districts, ranging from 300 to 500, or 600 pounds each. And their very small leg-bones have about such a proportion to their great size, as the legs of a Shetland pony would bear to the body of a Norman horse.

The custom of restricting the exercise of swine was first carried out in England, where they are short of room, being copied in America. In our Eastern and Middle States, where there certainly is no scarcity of space for exercise, the custom of English pig-breeders, in keeping their hogs in close quarters, was considerably intensified. America being largely a corn-producing country, the tendency of corn feed was to increase the proportion of fat, particularly in hogs, and in cattle that are much restricted in the extent of their natural activity. Greatly reduced activity, by increasing the proportion of fat in all breeds and ages of hogs, particularly in the leading corn regions of the wide West, causes a corresponding reduction of the muscle. And this tendency has been augmented so enormously, that in many places in the West, some hogs are met with that are so over-loaded with fat, and so small and weak in their muscles, that they are barely able to walk. Their blood being loaded and thickened with carbon, millions of over-fat hogs have become so weak in their bones and muscles that walking is evidently very painful, or almost impracticable; and being disinclined to walking exercise, the hogs, as a general rule, lie down and huddle together in throngs of scores to hundreds, during three-fourths or more of their lives, especially the large swine, in leading corn sections of the West.

The consequence of the reduced activity in multitudes of hogs in the Western country is a large reduction of bone, which has led to exercise being painful and limited, and also to an enormous reduction of muscle, thereby reducing the food-value of pork in proportion to the reduction of muscle; for muscle, as certainly in hogs as in cattle, contains nearly all the nutritive elements and flavoring juices of pork-meat. Consequently, every reduction of muscle in hogs is a reduction in the nutritive value, and therefore in the food-value of pork.

The reduction of muscle in many hogs from the joint influence of reduced exercise and increase of carbon in feed, within 25 years, amounts, we estimate, to 50 per cent less muscle, in proportion to size and weight of hogs, than existed in active hogs 25 years ago. And the aggregate extent of this reduction in the muscle and food-value of hogs we roughly estimate to be equal to that arising from the reduction of muscle in cattle, or 25,000,000 pounds, making together 50,000,000 pounds reduction and loss in flesh and food-value in cattle and hogs from the certain influence of reducing the exercise and breathing, and the circulation and muscular proportion, by reducing or preventing the natural activity, by which, only, muscular growth can be developed in young animals, or maintained in animals of any age, when already existing.

Whether it is because the form or the speed of cattle and hogs is not well adapted to the saddle, that cattle and swine are not permitted to regularly and sufficiently exercise, we cannot say.

But we see, as any one may see, that active horses and colts, and brood mares, generally, have plenty of exercise, and that thereby they develop abundant heat, and full muscular parts. This fact is observed every day, and at every turn, in all parts of the country; and horses are specially exercised by all good horse-breeders. Colts grow as rapidly in winter, in many cases, as in summer; growing all the year round, when they have as much or more exercise in winter than in summer.

What is the reason of this anomalous exception, in developing muscle by exercise in horses, and refusing exercise to cattle,* so preventing their developing muscle, or even maintaining what they may happen to have, at the end of each grazing season? Is it only because the horse is the better animal for the saddle or the carriage? Whatever be the cause, we are confident that the special exercise in the dry-feed season, and exercise at all seasons of the year, is as necessary for cattle and swine as for horses; and that such exercise, by developing or maintaining a fair proportion of muscle, would increase the nutritive food-value, and consequently the money value, of both cattle and hogs to about the same extent that their muscle or the nutritive flesh is increased, by increase of exercise and digestion, and resulting muscular proportion. The queer feature about this anomaly is: The same men who see their horses sweating because developing heat too fast by activity, will frequently carry water to their cattle that are housed, to prevent exercise, for fear of chilling their cattle by exposure to cold! They do not exercise their cattle to develop heat by activity, because the cattle shiver in the cold, showing very clearly that they develop too small a quantity of heat, because they get far less exercise than they urgently need. In such cases active exercise, by developing latent heat into active blood-heat, would prevent either cattle or hogs from chilling, or becoming tender, or

*"Deficiency of exercise often leads to fatty degeneration of the heart, with loss of power and derangement of the circulation."—Huxley and Youmans' Physi., p. 427

suffering from cold.* There is also a loss in good grass and hay, and other flesh-forming food supplied to cattle, that does not form flesh, in animals that are inactive, or still, from confinement or other cause. In the cases of fattening cattle and hogs, the proteid material is transformed into fat.

In store cattle, also, much proteid material is lost from inactivity during the winter, and there is great loss of muscle from inaction, after it is developed by activity in summer grazing.

The muscle of fattening cattle is wasted by inaction, and much of their proteid food either goes to form fat, or is lost in the droppings, or both these results follow their inaction, with the loss of food-value, as well as food.

The muscle-forming food that is wasted by misappropriation, as stated, and in other ways, probably would produce the value of ten million pounds of muscular, or nutritive meat food, if fed to growing cattle, or 50,000,000 dollars in money value. So that, including loss of muscle by store cattle in winter, the loss of muscle in multitudes of inactive or confined cows, and the loss, both in best or prize cattle, and ordinary fattening cattle, we have a total loss, in food value and money value, of 300,000,000 dollars yearly waste, resulting from the reduction of muscle and food-value, from reducing or prohibiting the natural exercise or out-door activity of only about *half* the cattle in the United States! including the loss in inactive hogs!

Three hundred millions of dollars yearly loss in food-value and money-value is not a small sum. The estimate is not assumed to be entirely correct, but is probably much below the actual yearly loss in food-value, from misapplication of

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*"Exercise, as is well known, increases the production of heat. It is through the increased activity of the circulation that the body is warmed by exercise. This is the reason why walking is so effectual in warming the feet, and why exertion of any kind raises the temperature of the parts employed," whether the legs, or arms, or the whole body.—Huxley and Youmans' Physi., p. 422.

feed, and reduction of flesh or muscle, resulting from the reduced or prohibited exercise of large numbers of cattle, and greater numbers of swine.

A seeming mystery, which surprises many feeders of ordinary steers, every season, is explained on this principle. When put up to fatten, many steers gain in *fat*, and seem to be doing well. But when put on the scale it is found that they have gained but little in weight. The reason is, having been active and their muscles full until they are tied up, their muscle, that was much increased by activity, is more rapidly reduced by confinement or disuse while they are confined to inaction, and the substance of the dead muscle goes to form fat. Thus, much of their fat is formed at the expense of much of their muscle. We have met with numbers of such cases.

Richer feed is no cure for the waste of muscle;* for that loss certainly results from inaction in any kind of domestic animals; as, while cattle or other stock are inactive, their rich feed, as well as much of their muscle, goes to form fat, which may wall in a little heat in the body, while much of the food is wasted in the droppings; but supplies neither food-value nor increase of weight when animals are confined and restless.

Active exercise is necessary for all other farm stock, or for fatting cattle, as certainly as for horses, to prevent shrinkage of muscle.

When Dr. Windship, of Boston, the once famous lifter, enormously developed the muscles of his chest and arms, his brain, and particularly his legs, shrunk to a very small size, showing that after mature growth, while muscle may be increased by active use in some parts, it is equally reduced by inaction in others. This is according to the law

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* "If deficient exercise be accompanied by free indulgence of appetite, perverted nutrition and positive disease will be the necessary consequence." —Huxley's Physi., p. 127.

of compensation, which requires the gain in one part to be paid for by corresponding loss in other parts.

There is no increase in digestive power from mere consumption of food. Digestive activity, or power to assimilate nutrient, arterial blood, cannot, in fact, be increased without augmented exercise and breathing. The calves that run with the cows in Western herds, for instance, could not increase their muscle and bone nearly as fast as they do, without the active exercise they get. Nor could the cattle that are thin in spring, regain or increase their muscle at grass, without the active exercise incident to grazing in summer. Muscle cannot even be maintained, but, as is well known, shrinks, in horses that are not sufficiently or regularly exercised.

We perceive that muscle in colts is rapidly increased by their great activity during the longest cold winters; and also that it is necessary for brood mares, which consequently breed vigorous, quick-motioned colts, that jump up as soon as they are foaled, because they are full and strong in their muscles, which are formed from the blood of the active mares.

Witness the magnificent effects of active daily exercise in millions of Western cattle, and many thousands of horses and colts, that are active on foot in the herds from sunrise till sundown, during the entire grazing season. In these great Western herds of cattle, calves, and horses, the constant activity develops 20 to 50 per cent more muscle and size in the same length of time than is developed by cattle that are tied up or confined to small pastures. Can any facts speak more strongly in favor of regular exercise for all kinds of farm stock in winter as well as in summer, than the certain increase of muscle, growth, and food-value in calves and cattle of all breeds, that make up the great herds of the West, as we have repeatedly observed, or than the rapid development of muscle in colts on almost every large farm, from active, regular exercise at all seasons?

Whatever the practical answer may be, we are confident that the coveted quality of mingled streaks of lean with fat in pork and bacon will not reappear in the meat of hogs, unless from the influence of increased and regular activity in large pastures. Nor can the equally-relished and desired juicy beef and fine-flavored meat be produced in cattle, without regular activity during their growth to develop the muscles. And moderate activity is necessary during the fattening of cattle to *prevent* the muscles from wasting away;* for only by exercise can muscle be developed or maintained. And activity is equally necessary to supply the muscles with blood, and prevent great loss from the dying and wasting of this most valuable part of animal growth, which is valuable for labor as well as for food.

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* See chapter on exercise for fattening cattle.

CHAPTER XVIII.

The Saving of Muscle in Fattening Cattle.

Exercise and Juicy Meat versus Waste and Degeneration of the Muscles.

The practice of Mr. John D. Gillette, of Logan Co., Ill., and others, in exercising their cattle, including the famous prize steers of 1877, led to much more discussion than would have taken place if he had failed to carry off the prizes at Chicago. But the superior quality of the beef produced by his out-door feeding, under the exercise incident to it, suggests a little further inquiry as to the causes of such a juicy and superior quality in his grade Short-horns, or any other cattle, there having been many other successes in feeding under such or similar management.

In many instances, prize cattle in the London market and elsewhere, have been affected with "fatty degeneration," or degeneration of the muscles; and, as this condition is met with in stall-fed cattle, while cattle having moderate exercise are *not* so affected, the origin of fatty degeneration requires some thought. It appears most conspicuously in a degenerated condition of the muscles that are necessarily used during exercise, suggesting the idea that inactivity gives rise to it, as this disorder is known to result from disuse, or inaction, in other parts of the system. It is necessary, first, to see how the size of the muscles is maintained, so that causes and consequences may be compared in ascertaining why the size and substance are reduced, or changed, under certain artificial conditions. Motion in the muscles causes wearing change; wear gives occasion for renewal, causing a demand for nutritive blood supply, in proportion to motion and waste.

Motion, or exercise, increases nutritive blood by increasing breathing, which completes the nutritive quality of the blood, by adding oxygen to it. Without oxygen, blood does not circulate. So exercise increases blood supply co-equally with, and in advance of, the demand to nourish or repair worn muscular tissue in all muscular organs and parts of the body. Thus, while motion is necessary to maintain the elasticity and size of the muscles, or muscular parts, it also increases the blood supply that is necessary in the fibres and strands of fibres forming the muscles, and in all muscular structure, in advance, and in proportion both to motion and to the wear arising from it.

Nutrition, practically considered, consists in the organizing of vitalized blood. This flows into the tissues and muscular fibres in proportion to their motion. It is this supply of blood that keeps the muscles and their fibre alive, by its organization. But organization, or renewal, in the muscles, is reduced or ceases in such degrees as motion or use, and blood supply, are reduced and discontinued; and muscles rapidly waste away, fibre after fibre disappearing, from the inaction resulting from rapid and extreme reduction of exercise.

Muscles may recover their size again, if exercise—which develops fibrin in the blood, be increased sufficiently and early enough, to insure the requisite blood supply to the muscles corresponding with reduction in motion and wear; and the blood flow in the fibre vessels ceases entirely soon after complete inaction and disuse in the muscles and fibres takes place. When the action of the fibres ceases, their circulation also ceases; *organization* ceasing in the fibres from the *stoppage of their red-blood circulation.*

When blood flow and organization cease in the fibres of muscles, disorganization begins. The fibres die as their circulation ceases. The muscle substance is nearly similar in *color*, to fat, after the red blood ceases to flow in and color it; and being no longer supplied with blood, the dead substance of the fibres is rapidly disorganized and transformed to fat-like matter, the dead matter of the fibres being in this state *added* to, and *increasing* the quantity and proportion of fat; at the same time equally *reducing* the quantity and proportion of lean flesh, or muscle tissue.

Many fat cattle have sufficient vigor of muscle and circulation to escape this disorganizing process—the fatty degeneration of the muscles. But others are seriously affected by it. The disorganization of the fibres and fascicles of the muscles results from disuse and inaction in the legs or other affected parts of the animal; this inaction itself resulting from reduced or prohibited exercise.

When fat cattle are constantly and closely confined, exercise, in that case, is so far prohibited. If they are too fat to take exercise, inaction or disuse in their locomotive muscles, is the result. The more loaded with fat, the greater liability of cattle or hogs to muscular inaction, and in parts to disorganization; while the size and action of the lungs are certainly reduced according to reduced activity, when the inaction is long continued. And in numbers of cases the contractive muscular action of the heart and the size of its openings are reduced; its circulating force being impeded and enfeebled by the accumulations of fat within its passages; which, practically, is degeneration of the substance and natural power of the heart.

Having briefly explained the nature and main cause of reduction in size, and degeneration in the substance of muscle, which takes place mainly in the parts that are made active during exercise, and which become inactive in the degree that exercise is prevented or reduced; and which die from complete inaction, their dead substance being then transformed into fat, by disorganization; our remarks on this topic, though brief, cannot be further extended.

In alluding to the practice of Mr. John D. Gillette, and others of Central Illinois, in fattening cattle in their groves and pasture lots, thus allowing them to indulge in considerable voluntary exercise, it was stated that other successes from similar management had been observed. For instance, Hereford steers have been, and probably still are, frequently fatted and finished off in England on good grass, in open pastures, and without night penning; and the juicy quality of their beef is abundantly well known in the London and other markets of that country. On a more extended scale, Short-horn grades and fine common steers and heifers, in hundreds of herds, and many thousands of instances, fatten rapidly and well on the ample, open Western ranges of rich grass, fully maintaining their muscular proportion by adequate daily exercise. And many steers are fatted during winter weather in ample yards, provided with simple sheds, these cattle voluntarily seeking shelter or indulging in gentle activity, as they require.

In such cases we have noticed that the skin thickens by exposure, thus insuring in it a larger supply of blood and blood heat, and ability to bear the escape of heat from the skin, and to form sufficient blood, and supply sufficient heat, to prevent suffering or injury from cold. And this natural and simple way of developing power of endurance —even on the way to the block—has marked advantages in certainly maintaining nutritive meat quality, as is conspicuously shown in the success of Mr. Gillette, whose cattle are, it seems, so good in *quality* as to suit the much cultivated taste of critical English connoiseurs and consumers.

The question here arises: Why is it that cattle fed in the open air, and having opportunity to indulge in moderate voluntary exercise, make so excellent a quality of flesh, and supply so good a quality of meat, as to satisfy the best judges of meat either in American or English markets? The answer involves several facts and advantages, all traceable to one main cause, which is *out-door exercise.*

First, the nutritive value generally of meat is according to fullness and bright color of its muscular or fleshy parts. Second, the bright color and fleshy proportion are according to the proportion of muscular flesh, and its bright red color, which result from adequate voluntary exercise and breathing, while augmenting weight by fattening, *without diminishing muscle*, by inanition and waste, or by fatty degeneration arising from inaction. Third, in addition to its substantial nutritive value, the flesh, or muscular proportion of beef-meat, contains and supplies the nutritive juices as well as the flavoring qualities of roasts and steaks, and of the general meat product of beef cattle, showing conclusively that the success attending open-air feeding, which provides opportunity for adequate exercise, consists in maintaining the proportion of muscular flesh of the cattle *undiminished* while they are being fattened, so by moderate action maintaining circulation and life in the muscle, and thereby producing healthy, juicy, fine-flavored flesh, with sufficient fat in the cellular tissue, thus supplying a far more nutritive, juicy, and finer flavored quality of meat than is possible by stall feeding, or feeding under close confinement.

The quality of fat also in cattle that exercise while fattening, is far superior to that formed under close confinement and inactivity, as in stall-fed cattle.

Steers generally, when freshly tied up after active summer grazing, frequently gain but little in weight, although well fed and having the appearance of doing well. The reason why they gain but little in weight, though fully fed, is their loss of muscle, much of which dies from inaction, caused by stillness or tying, and the transformation of the dead muscle-substance into fat. So the food-value of their meat is reduced according to the reduction of muscle caused by the sudden and continued arrest of exercise, with the corresponding reduction of breathing and *red* or oxygenated blood. When cattle are suddenly tied up they suffer much pain, which causes restlessness and imperfect digestion, and prevents thrift, causing the loss of much nutrient food-material in the droppings. So, on the whole, it appears that cattle will gain quite as much in weight when not tied up at all to fatten—excepting unruly or vicious animals; for when exercise in large yards or in pasture lots is allowed, there is no loss of muscle from inaction; and though no muscle-substance goes to increase the proportion of fat, the proportion of nutriment in the meat is far greater *with* than without exercise, because there is more red muscle-flesh, and the juicy quality it supplies in the beef when fattening cattle are allowed regular exercise. In other words, exercise saves food-value, by preventing loss of muscle, while tying up reduces food-value, by causing much loss of muscle, which latter contains the nourishing juices and qualities of beef for food, which is practically illustrated in the success of John D. Gillette, and other extensive cattle feeders in Central Illinois.

The same principles apply in the feeding of hogs. It is only necessary to insure moderate activity while the animals are fattening, in either case. But it *is* necessary to maintain the full proportion of muscular or lean flesh in the meat, for the fullest and best nutritive quality can be kept up in *no other* way than by moderate daily exercise. A case in point:—

In Green Lake county, Wis., a number of successful farmers and feeders fatten their hogs mainly in the clover-field, as probably happens in other localities. One of their number*—a model farmer—fattens about 100 Berkshires a year, in this way, with full success.

By gentle exercise the muscle fibre is kept *alive*, and the natural proportion of lean flesh in the hams, and generally throughout the animal, is maintained. The fat accumulated is thus *added* to the lean basis instead of transforming much of the lean flesh into fat, so wasting muscle, as is done by keeping either cattle or hogs closely confined and inactive while they are fattening.

The bright *red* color and fine flavor in steak and juicy beef, and in ham and bacon having mingled layers of fat and lean, indicate nutritive value in the quality of the meat; the bright color being due to the presence of vital oxygen, supplied in extent according to gentle exercise, so maintaining the flesh basis or muscular proportion in fattening animals of any kind, in contrast with the inferior quality and poor flavor of dark-colored meat, that are mainly due to confinement and the presence of excretory matters in the blood.

To purity of quality, greater nutritive value, juiciness, and fine flavor, add the higher price for superior value, the greater certainty of demand, the satisfaction arising from success—and all from maintaining the natural muscular basis of fattening animals by gentle or moderate exercise, while adding fat; this series of advantages appears sufficient to warrant the continuance and extension of the practice of giving gentle exercise to cattle and hogs while they are being fitted for use to supply meat-food of good quality.

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* Hon. Sam. W. Mather.

CHAPTER XIX.

TRAINING, FEEDING, AND BREEDING:

Or Developing Food-Value in Farm Stock.

Balfour Stewart, LL. D., says in his treatise on saving force, that "we make use of the animal, not only as a variety of nutritious food, but also to enable us *indirectly to utilize those vegetable products, such as grasses,* which we could not use directly, with our present digestive organs," and it is substantially correct to say that the leading object in raising cattle is to produce the best quality, and largest quantity of meat-food, by employing the cattle to organize vegetable structure, or feed, into their own growth. For, neither animals or man can form structure, or growth, except from previously organized structure. Thus, while the structural or organized parts of animals, such as muscle and allied growths, afford us nourishment, and can even be transformed into organized tissue, fat affords no direct nourishment, because it is "structureless, unorganized matter,"* not capable of forming muscle, or supplying structure-forming material. It is important, therefore, to devote our cattle feed to forming such *cattle structure* or growth as will serve the purpose of really nutritive food, in the form of flesh-meat, when the cattle products come to be consumed as food. And it may again be stated, that only organized structure that has been previously formed by natural growing processes, whether animal or vegetable, can be converted into human growth, or vital structure, or afford nutriment for assimilation. Hence all

* Dr. L. S. Beal, in Physi. Anat., last part.

the fat, beyond what may be required for culinary or merely condimental uses, that is produced in raising cattle, represents a waste of the grasses, hay, or other cattle feed, that might be more readily and profitably converted into muscle, or other *real* growth, than into fat, which is not growth, nor a product of growth, but simply accumulated "structureless matter." The animal structures that are nutritive, are those parts that are organized, and necessary to life and motion, such as the muscles, nerve-substances, and allied parts.

Muscle naturally comprises over half the weight of cattle, and it constitutes the most nutritive and valuable part of beef, namely, the red flesh, or juicy portion of the meat. Hence cattle and their meat are nutritively valuable, according to the extent of their muscular proportion, or the quantity of their nutritive or organized flesh parts.

It is established that exercise is necessary to develop muscle, because all the different degrees of muscular development in man and animals are the result of, and correspond to, the degrees of exercise which habitually have developed such quantities or proportions of muscles together with other organized structures. Hence any degree of muscularity in the nutritive value it affords, cannot be increased, nor even maintained, without a similar degree of regular exercise to that which originally developed such extent of muscle.

For illustration, if twenty steers be turned into a forty-acre lot of stout, thick grass, they quickly fill themselves, and lie down to ruminate or repose. With so little* exercise, the stock have their arteries engorged rapidly with thick blood, that increases fat—not muscle—rapidly, be-

* If deficient exercise be accompanied by free indulgence of appetite, * * * naturally there is an abnormal accumulation of fat, amounting to *actual disease*, and a disturbance of the nutritive forces that undermines the healthy structure of the tissues. Nor is this muscular deterioration limited to parts that are unused; the involuntary mechanism also becomes implicated.—Huxley and Youmans' Physi., p. 427.

cause assimilation is slow and imperfect, and the parts of the blood, that, with sufficient exercise would be organized into muscle or other living structure, are not organized at all; but accumulate as unorganized accretions of fat, that are not nutritive as meat-food.

But turn thirty steers into the same lot of grass, as early as there is a fair bite, so that two hours' exercise will be taken while the steers are filling themselves. With such an extent of exercise in gathering their grass feed, most of the growth and increase in weight in the steers will arise from increase in muscle, and other organized structure, that is nutritive when used for food. So by managing in a way to allow young cattle to become indolent, inactive, and quite fat at pasture, they increase their muscle and food-value but little, and the meat consumers get but little nutritive food from the grass so appropriated to forming fat. But when the same quantity of grass feed is consumed by growing cattle that are active two hours at a time three or four times a day, from 20 to 30 per cent more muscle and nutritive food, in the form of fleshy meat, is produced from the same quantity of grass feed. So by developing muscle and allied structure from the influence of regular exercise, we obtain real food-value *indirectly* by converting grass into organized flesh structure. But if the cattle are allowed to become indolent and inactive, they increase more in fat than in muscular structure, or nutritive value, and the grass feed produces far *less* food-value in fat from inactivity, because it does *not* form near as much nutritious meat or muscular flesh, which is developed only with regular exercise.

Cattle that are well grown in their muscular parts, and in smooth condition, afford an abundance of fat for the cuisine and condimental purposes, a fact which consumers are now generally appreciating more than formerly.

Many other modes of management that secure regular activity, as the necessary condition of developing muscle from feed, and so producing meat that is nutritive, instead of preventing muscular development by inaction, or indolent action, may be adopted. The rule and object being to convert the most cattle food into the most valuable parts of animals that are used as meat food. And to accomplish this object, the influence of exercise and regular training should be fully and practically recognized at all seasons of the year, and in farm-stock generally.

It is a great mistake to disassociate training as a necessity from breeding as an art; for breeding can never be truly successful without close attention to training. We are confident that the true interests of producers and consumers of meat and other cattle products, are not antagonistic in any case as to the best use of feed in producing muscular meat-food, or other cattle products of value; the hide itself being as truly an organized structure or growth, and as much increased in substance and value from the influence of regular exercise, as muscle, bone, or other organized structure, while equally as valuable and as much in demand.

So in reducing necessary exercise or neglecting it, other products as well as the meat food are reduced in extent and value. In fact, too much restricted exercise is a great error by which any cattle are injured, and high-fed inbred cattle are most depreciated in value.

The full proportion of exercise and muscle that supplies labor-value in horses, also supplies food-value in nearly all other farm stock, a fact which numbers of Shorthorn breeders have apparently ignored by restricting or confining their cattle to very limited exercise; and Jersey and Guernsey cattle are tethered from lack of pastures, the consequence being very light muscle, vigor, and food-value in many cattle of each breed on the Channel Islands.

Breeding that does not increase nutritive value, is breeding that does not improve.

The cardinal principle in breeding is, or should be, to increase food-value first, and maintain it subsequently, as the chief basis of commercial value in all meat produced for food.

Activity or training and selection have supplied good Norman and English horses, variously modified by breeding and use in England and America.

The muscular development for work-value in horses, and food-value in cattle and swine, results from the influence of their regular activity, when fairly fed, as during the muscular contractions the inflow of blood to the muscles takes place at a rate according to activity.

The law of inheritance being, that the existing state, whether of health or disease, or full or feeble muscles, will be transmitted, makes improvement by breeding a slow process. But by gradual, unconscious selection, a few naturally developed breeds, such as the Devons, Herefords and Galloways, and others, have come down to us, and been made somewhat uniform in color and quality by special selection and suitable pairing.

The best horses, cattle and sheep have all descended, or ascended, from *inferior* common stock, the best in each generation having been long selected in many instances. Finer improved grasses of digestible quality have made the quality of flesh finer, while vigor was maintained by full activity in sheep, swine and cattle.

The business of the breeder is mainly confined to selecting and combining the best forms and qualities within his reach, pairing the animals, so as to cure the defects on one side by excellences on the other. If the paired animals are both good, some improvement may result. But there may be deterioration in form or quality from hitherto latent power, transmitted by one or more ancestors. Where there is little muscle there is little vigor transmitted by any farm stock; and as muscle, if above the minimum extent surely wastes from inactivity, the food-value, which is nearly all supplied in the muscle, can neither be increased nor maintained by breeding without regular training or exercise.

Inaction, by arresting motion in the muscles, arrests the inflow of blood, causing the muscles to die* gradually and waste away. The fact just stated is the reason of exercise being a necessity to develop or maintain muscular structure, for food-value or for labor; and the failure to recognize this fact has led to very deteriorating results in reducing the food-value of cattle and hogs, in many instances, and in great degrees.

The best breeding selects the most *vigorous* stock as the basis of improving food-value; and this depends both upon the judgment of the breeder, and the extent of his opportunities for selection, which are much wider when inbreeding is not practiced. Inbreeding narrows the field of choice, and the means of improving as much, even in widely extended breeds; breeders of the same sort of animals, whether sheep, swine, or cattle, usually pursuing a nearly similar course with similar effects in their stock; the neglect of active training having long been a cause of declining vigor, and reduced fertility in many inbred cattle, while goitre in lambs is probably due to inactivity in the ewes. Inbred cattle necessarily inherit the leading defects of their family or breed, while cross-breeding affords a very much wider field for selection of any quality or form required to cure defects, or increase any good points or qualities of growth. Cattle also generally become less active from special feeding and other causes,

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*See Foster's Physi., p. 65.

tending to a reduction of muscle and vigor,* while their reduced food-value and vigor can possibly be augmented by gradually increased exercise, when not too far reduced. Of course there is most need and margin for improvement in slender-muscled animals of any sort. Illusive improvements in certain Short-horn cattle, in the Bakewell sheep, and in millions of hogs, have been at the expense of muscle, and loss of food-value and vigor; and in some cases, of fertility. But vigor and fecundity rapidly increase in Short-horns, or other animals, when the necessary exercise, as the law of muscular development, and increase in digestive power and food-value, is permitted or enforced; exercise increasing organized structure and value, while inaction merely increases *un*organized fat at the expense and by the repression of muscular growth.

The cardinal rule in breeding should be, as already stated, to increase food-value, or at least to maintain fullness of muscle as the source of value; and fine forms, as is well shown in the Devons, which have maintained their vigor, and value by natural activity in their locomotive organs. And the same process is now developing muscle and value in thousands of grades of Short-horns, and probably millions of other cattle, with many horses, on the open Western grazing grounds, affording a vast increase in food; and improvement in food-quality and value, as the result of regular activity.

It is the influence of regular exercise that increases nutritive value, juicy quality, and good flavor in any sort of meat; but inaction destroys these good qualities, in great degrees, by displacing them with structureless fat, that has little or no direct food-value.

To our view, special exercise, if voluntary activity is insufficient, is quite as necessary to develop and maintain

*"As exertion favors nutrition and the healthy development of active parts, inaction impairs nutrition, reduces the size of the muscles, and gives rise to feebleness."—Huxley's Physi., p. 426.

power for labor, and food-value in one breed of cattle as another; and in cattle, as in horses; and food-value in swine, and in inactive sheep, as in cattle, as lack of adaptibility to the saddle or carriage should not be a bar to the natural use of the locomotive organs, and activity in breathing, by the use of which, to a reasonable extent, vigor and health are conserved, and food-value increased more certainly and by a simpler and more economical method, than is possible without such necessary activity or regular exercise of the locomotive organs. When muscular growth is slight in extent, the food-value is correspondingly small. When the extent of muscular parts is full or large, the extent of food-value is large, corresponding with the quantity of muscular flesh.

It is also true that power for motion or labor, or to maintain health, is according to the extent of muscle, in cattle or horses of any breed. Full muscular growth is necessary for power and activity, as well as to supply nutritive value and quality in meat.

Breeding without activity cannot develop or maintain muscle, or food-value in cattle, horses, or swine; exercise being a necessity to develop or maintain the muscle which contains the food-value.

Muscle dies by inaction, and wastes away, so wasting food-value by reducing or prohibiting exercise.

When muscle is full, exercise only can maintain it, and when muscle is deficient, exercise is necessary to increase it.

The nutritive properties of meat being mainly contained in the red flesh or muscles, or in the organized parts, exercise by developing or maintaining the muscular or organized parts, becomes a necessity to maintain the food-value above the minimum that exists with inaction. And, whatever the quantity of feed supplied, inactivity reduces the food-value by diminishing the quantity of muscular or other valuable organized structure, that contains the nutrient qualities which make meat valuable as nutritive food.

The effects of regular exercise in developing muscle and food-value in active cattle, and power in horses, are clearly evident. But inactive cattle, and hogs, and sheep, that have been compelled to inactivity, also have lungs and locomotive organs. They also have equal need of exercise to maintain muscle and health, together with food-value in their meat.

It is not practicable to abolish the locomotive organs or lungs of inactive cattle, hogs, and sheep ; nor would it be convenient to prohibit the activity of horses. Nevertheless, the inactive legs and lungs of the inactive animals were developed by activity, and require using regularly, to maintain size and power.

In view of the foregoing, we recommend that the wide distinction between the active and inactive animals named, be abolished, by allowing or compelling a reasonable degree of activity in the lungs and locomotive organs that are heedlessly compelled to inactivity. By abolishing this distinction, and substituting regular out-door exercise, the animals will get a fair chance to develop muscle, and increase their value, in the only practicable way, by activity ; thus benefiting breeder and consumer, by increasing food-value, while the animals are enjoying the beneficial process that increases their value and vigor, as active horses and colts, and cattle evidently enjoy such a natural and necessary use of their lungs, and locomotive parts.

BOOK THREE.

CHAPTER XX.

Abortion Extraordinary in Cows.

Increase of the Malady.—Some of its Peculiarities.

INTRODUCTORY.

The characteristic facts of the abortion in cows that commenced about the same time that cheese-factory dairying was first inaugurated in the State of New York, are so peculiar that we give a short introductory chapter to the consideration of some of the most important of them.

The number of aborting cows in 1868 was about 5½ per cent of all the cows in the State of New York, and the proportion is probably as large in some localities in Pennsylvania, Illinois, Wisconsin, and other States, where special dairy cows yield as much—70 per cent—over the general average of cows in their respective States.

In Herkimer county, New York, the number of aborting cows in one season, 1868, was 1,650, the loss in milk being equal to the yield of 822 cows, or 356,529 pounds of cheese, in only fourteen towns.

Such facts may suggest the sweeping extent of the malady or injury, and the loss arising from it in other cheese-dairy districts, and the pecuniary and physiological importance of the subject to farmers and dairymen generally.

The most remarkable circumstance connected with extraordinary abortion in dairy cows, is that the malady is not distinguished by, and presents no marks or symptoms of, disease or injury, other than those of starvation of the embryo—as shown by several dissections—and the consistent result that nearly all the embryo calves are *dead when aborted;* while ordinary old-time abortions result from causes that leave no evidence of starvation, nor do the cows sustain impairment of their breeding power; but many cows affected by this modern kind of abortion, certainly lose the power to breed in many instances.

This modern variety of abortion is also peculiar in another feature: In occurring in numbers or clusters of cases together, offering—in this sole and accidental circumstance, but in no other—one suggestion of an epidemic. It is not, however, epidemic in any degree.

Another peculiar feature of the malady is, it intermits farms, herds, and localities that fit in between or adjoin affected herds, the cows in some cases bringing their heads and their expired breath into near contact, which would certainly lead to the spread of contagion, if there were any, but not infecting the proximate or exempted herds, by such close contact, which shows clearly that this new kind of abortion is *not* epidemic.

These and other peculiarities, particularly the established fact that it "does *not* result from any of the known causes of abortion in the human subject, or in animals," entitle this malady to be classed as "Extraordinary," and we so name it accordingly.

Its recent origin, at least on a noticeable scale on this continent, is also remarkable, as it seems to have first appeared in clusters of cases together, about the year 1856, or soon after cheese-factory dairying commenced.

In 1861-2, abortion increased considerably in the then leading dairy counties of New York. The increase continued forward till, in 1867-8, it prevailed so intensely—

not widely—particularly in the neighborhood of cheese factories, and inflicted such heavy losses of calves, and the use of cows, that the dairymen of New York procured the appointment of a commission, composed of skillful physicians and surgeons, with Dr. J. C. Dalton, the eminent physiologist and writer, at its head, to investigate the subject. But, after a vast amount of intelligent labor, extending over the three seasons of 1867-8-9, the inspection of 1,577 or more farms, and of 14,000 or more cows, and reading and scrutinizing 4,250 reports, sent in by dairymen from ten States, chiefly from New York, Massachusetts, Iowa and Ohio, this able commission relinquished its extended search for the origin of this peculiar disorder, promptly admitting the "negative results" of their investigation, and stating that "no claim was made that any of the predisposing causes pointed out, nor any one of them, gives a rise to this trouble."*

Causes of Ordinary Abortion Ruled Out.

These strange—but *not* inconsistent—results take place, while there are *no marked symptoms of disease in the cow, nor in the embryo*, "other than the *stoppage of its circulation*," and the "consequent *arrest of growth*," *causing its death.*

The fact that nearly all the embryos are dead when delivered also strongly indicates their *starvation*† *previous* to their abortment.

* It must be as clearly admitted that several of the significant facts established by the Commission have been suggestive to us, while studying out its peculiarities, and tracing this extraordinary malady to its origin. Most of the facts established by them point in the true direction; but the Commission failed to think of the fact that the size and *normal condition of the udder supply arteries must be as much affected by increase of blood* as the udder evidently is by increased milk-yield, and its expansive force.

† Said Mr. W. D. Hoard, then President N. W. D. A., at Ft. Atkinson, Wisconsin, November, 1879: "My father used to say, 'They—the aborted calves—look as though they were starved to death.'" I replied, "He was right, for all that are dead when delivered—which is nearly all that are aborted—certainly *are starved to death.* And I have discovered the cause and mode of this extraordinary consequence."

Such predisposing influences of old time abortion as fright, sympathy, worrying, hurts, straining when mired, exhausting fatigue, etc., are ruled out by the evidence, as none of these account in the least for the *stoppage of the circulation*, and the *clear evidences of starvation*—as observed by dairymen,* in the emaciated condition of the embryos when aborted—and alluded to by Dr. Dalton,† who also states that this malady is *not* epidemic in New York. We will add that it is not even a disease, in the ordinary sense of the term; but is the result of serious structural derangement in the size and use of mammary arteries—those that lead to the milk glands—the derangement resulting from the engorgement and relaxation of those arteries which, at their extremely enlarged size, convey so much of the mammary blood to the udder, that not enough is left to increase the necessary supply to the placenta, or continue the growth of the embryo; hence its death from deficiency of nourishment, and its expulsion a necessity to save the cow.

The engorgement and relaxation of *udder-supply arteries*—which we find to be the cause of this malady—is of an *extraordinary* nature, being clearly *mechanical* in its effects on the arteries in question. And in this fact consists the evidence that the disorder in these arteries, or their relaxed condition, results from excessive expansion, by too rapid increase of blood, which is a consequence of the extreme mechanical distention incident to extremely *rapid* engorgement. So this extraordinary variety of abortion results from engorgement of the arteries that supply the udder glands with blood, the too great and rapid increase of blood being the result of equally great and rapid in-

*In the towns where abortion prevails in New York, 71 per cent of the abortions occur after the sixth month of pregnancy, when much more blood is required by the embryo for increasing its growth and size, than at an early stage of embryo development or pregnancy.

†See report issued by New York State Agricultural Society, Albany, 1868.

crease in the *feed* of the cows, whose arteries are consequently engorged, and their udders similarly filled and engorged with milk formed from a sudden increase in the quantity of artery blood supplied to the milk glands.

There can, we believe, be no just cause to doubt that milking pregnant cows too late is antagonistic to their breeding power; that yielding much milk during pregnancy tends to dwarf embryo growth; nor that special dairy cows—which yield 70 per cent of milk above the average or ordinary yield in the dairy districts of New York, and other dairy sections—must, some of them, fail to breed, and others breed only small calves; and, in fact, only small calves are bred by many cheese-dairy cows, numbers of which have their udder-supply arteries relaxed to a greater or less extent, the natural extent of blood nutriment to the embryo being consequently reduced, so reducing the rate and extent of growth, and the size of the calves.

These introductory and other remarks are made chiefly to point out a few leading facts and characteristics of abortion-extraordinary in milk cows, to acknowledge the mode and research by which the facts were ascertained and established, and to show the consequent certainty of the facts stated. And we believe our conclusions will be found to be equally certain.

After careful study of the striking and peculiar facts already noticed, as fully established by the manifold, long-continued, extended, and careful researches of the New York commission;* and examining numbers of cows, and various herds in Wisconsin, as opportunity offered through a period of seven years, and several years devoted to necessary study and other research, we became convinced

*The investigation extended over the three seasons of 1867-68-69. See reports of Drs. Dalton and Carmalt, published in 1868 and 1869, by the New York State Agricultural Society, for copies of which we are indebted to the kindness of Mr. X. A. Willard, of Herkimer county, in that State.

that UDDER SUPPLY ARTERY ENGORGEMENT is the sufficient, main, and consistent source and cause of *embryo starvation*, and the necessary abortment succeeding, as the effect of *over*-strain and relaxation in the udder supply *arteries*.*

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* To give a simple and practical demonstration of the effect of extreme expansion of the udder-supply arteries, or rather of the thickness of the walls of these blood-conveying vessels, we procured a piece of small rubber tubing, about a half-inch in diameter—a smaller size would be better. Cutting off a piece four inches long, we inserted a plug of wood, large enough to double the size of the tube, in one end, cutting off the plug close to the end of the rubber. The thickness of the tube-wall at the expanded end of the tube is *reduced* by this method of expansion to about one-half the thickness of the wall in the small or *un*expanded end of the tube. A similar thinning of the walls of the udder-supply arteries takes place from over-rapid and extreme rates of increase in blood and yield; the other results stated following according to the various degrees of artery expansion and relaxation, that result from very rapid increase in blood and milk yield.

CHAPTER XXI.

Abortion Extraordinary in Milk Cows,

From Artery Engorgement and Embryo Starvation.

That there is an antecedent increase of blood in the udder-supply arteries, corresponding to any increase that is made in yield, is equally necessary and certain. And that such increase in blood, when large and rapidly made, engorges these arteries is very evident. Several important, but *un*natural, changes in the udder-supply arteries result from their engorgement:—

First, excessive and excessively rapid expansion of the arteries that supply the milk-glands with blood, results from equally excessive and rapid increase in the bulk of blood, and the quantity of food it is formed from; the evident proofs of this being found in the udder and the milk pail.

As is well known, the milk-yield of cows, particularly in those supplying cheese factories with milk, is, in numbers of instances, *doubled* in less than three months of time; in some instances 70 to 100 per cent increase in yield being made in six to eight weeks. In instances where so large an increase is made in three months, this *increase* in yield is at the rate of 140 to 200 per cent or more in six months, which is a short milking season, there being a corresponding increase in the size of the udder and its supplying arteries at the same time. This increase of blood in the mammary arteries supplying the udder is so large that, if continued, it would enlarge the tubular size of these arteries at the immense rate of 420 to 600 per cent in only *three* milking seasons!

But if we assume the yield of cheese-dairy cows to be increased at the average rate of 70 per cent more than the general yield of cows, as takes place in the dairy districts of New York, and that in many of the cows employed—those newly purchased and unaccustomed to the full and special feed they now first receive, more than others—the yield is increased 70 per cent in two seasons, or in fourteen months—the cows being actually milked only eight of those months—beginning with May, and extending till 1st of July the *next* season, even this rate of increase in yield involves a rate of increase in blood, and in the *size* of the *artery tubes*, that convey it to the udder-glands, of 300 per cent in five seasons!

Now, the question arises: Can cows, of any breed or extent of stamina, bear such a rate of increase in the tubular size of their udder-supply *arteries* without injury in the walls by relaxation? But the *average* increase of 70 per cent involves a higher *actual* increase of 35 per cent in yield and blood more than the average, by about half the number of cows from which the average is made up, which extends the addition in yield and udder size; and also the increase in artery blood and artery size up to 105 per cent increase, and in some exceptional cases up to 120 or more per cent over the average yield; this increase in blood supply and artery size of the cows making up the large average of 70 per cent, which is the excess of increase in the yield, and in the artery blood and artery *size* in special dairy district cows in Herkimer Co., New York.

But this large increase in yield and in artery size, is not of itself and alone the sole operative cause leading to the starvation of the embryo in aborting cows.

It is simply necessary here, however, to show the fact, that the arteries conveying the blood from which yield is formed are enlarged by distensive engorgement, to the same extent that the milk glands and bag are enlarged.

2. The engorgement of the udder-supply arteries, when the increase of blood is too rapidly made, thins down the artery walls much faster than their circulation thickens or repairs them; so that many cows abort because the artery-walls are so much thinned and weakened that the cows can no longer contract their udder-supply arteries. This is the effect when a large, or very large increase of blood and yield is very rapidly made, taking *less than half* the safe length of time, compared with the time taken in Holland, for instance, to make as large an increase in blood and milk-yield.

Two things should here be considered :—

1. Elastic muscles lose their contractile power, simply by inaction or disuse when this inaction is too long continued; and the loss of elasticity becomes permanent when the uncontracting state continues several months.

2. It cannot be disputed that the mammary artery walls are very much thinned down by great degrees of rapid engorgement; nor that extreme engorgement continues or is increased, as long as a large addition to yield continues, or is increased! The long continuance of the artery walls in this thinned-down, inactive, and uncontracting condition is therefore clearly evident.

Inaction for a long time would alone lead to the loss of artery elasticity. But when this relaxed condition is coupled with a reduction of half the natural thickness and strength of their walls, and this stationary and weak condition is certainly long maintained; the same bulk of blood and its expansive pressure, that first engaged the udder-supply tubes, being continued, as the condition of continuing the large yield,—in such cases the relaxed condition of the udder-supply arteries is therefore made chronic, from their tubes being thus kept as much expanded by continued distention as when first relaxed by excessive engorgement.*

But a further and strong auxiliary influence that intensifies the engorgement of the udder-supply arteries, is found in the engorgement of the milk-glands, both in cows, and heifers that have never been milked. In such cases there is the storage of their twelve-hour, or half-day yield, altogether in their udders; their arteries being similarly engorged; and a similar accumulation of milk in the udders, and in the blood-supply in the udder-supply arteries of heifers takes place long before they calve. The engorgement of the milk-glands in these self-evident ways arrests the flow of artery-blood before it can enter the milk glands; this engorgement in the glands and in their supply arteries continuing for weeks in some heifers, and being relieved but once in twelve hours in cows at the pail. The "back setting" as millers call it, of the blood from this cause must extend far back in the arteries, condensing the blood, and intensifying the pressure of extreme engorgement in great degrees and so thinning down the substance of the artery-walls in certain proportion to the increase in conveying size of their tubes, or in the degree corresponding to that of their further engorgement and expansion, from this back-setting of the blood.

This must be the necessary effect of too abrupt or extremely rapid artery expansion, intensified by back-setting of the blood. And any rate of expansion that is more rapid than the increase of thickness and strength in the artery walls by nutrition from the circulation, is too rapid, and therefore excessive.

In such cases, the artery walls are weakened by expansion faster than they are strengthened by nutrition, becoming in a little while too weak to perform their natural

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*The effect of engorgement in thinning the artery walls is illustrated in cuts, also given in table.

work or functions. And this is what actually happens to the udder-supply arteries from over-rapid expansion by very hasty engorgement with blood.

It is manifest from such facts and results that such of the mammary arteries as supply the milk-glands with blood, are in many cases so over-much expanded and relaxed by engorgement, that the engorged size in many cows becomes permanent, from the prolonged *continuance* of the engorged condition, and the extreme weakening, and the loss of contractile action and contractive power taking place in the udder-supply artery walls.

3d. It is evident from several considerations that pregnant cows require, and have naturally and automatically the power to contract their mammary arteries; for this power evidently is necessary to enable them to breed by increasing the placental circulation, which supplies the nourishment to their embryos, and such contraction is a necessity of breeding power.

If such contraction did not take place instinctively, or from nerve action, by what other agency can the blood be directed to the embryo?

The evidence goes to show that the nerve centers which rule blood-supply to the udder, receive impressions of embryo hunger, and respond by causing contraction in the mammary arteries, which reduces the rate of milk-formation, and turns the nutritive currents, thus gained, to the supply of the embryo.

We believe there is no other power but that of contracting her arteries, when the reflected impressions of hunger require, that can enable a cow to nourish her embryo, as she naturally does, in time and quantity according to the size and demand of the calf she is breeding.

Two facts sufficiently show that cows do control so much, at least, of their mammary blood-flow as is necessary to form embryo growth, and thus make breeding possible, the last-named fact being indispensable and natural:—

1st. Cows necessarily supply their embryos with blood nutriment, when they feel the embryo hunger through the combined nerves of both.

2d. They naturally *increase* the blood supply to the embryo according to its increase in size and constantly increasing demand, to form the equally constant enlargement—which is growth—till pregnancy terminates.

It is also true that some cows starve their own tissues more than they should, from strong nerve impressions that it is necessary to nourish their embryos, which is an evidence that they direct the mammary blood flow by nerve action.

A large majority of cows increase the blood supply to the embryo by contracting the udder-supply arteries; in this way increasing the flow of blood to the embryo by reducing the supply that is flowing to the milk-glands.

By contracting the udder-supply arteries, they increasingly nourish their embryos, and at the same time reduce their milk-yield, until the enlarging growth of the embryo and the increasing contraction of the milk glands and their supply arteries, entirely dries up the milk-yield, by contractively reducing and at length stopping the flow of blood to the milk-glands, or udder.

The propulsive force of contraction, alternately with expansion, propels the artery blood generally. But it is inconceivable that the mammary circulation could be reduced in one direction, and increased in a different direction, as it evidently is, in quantity according to the size and needs of the embryo, otherwise than by the cow controlling the blood flow that supplies the udder, by contracting the udder-supply arteries. Contractile power propels the mammary blood *towards* the udder, in the season of its use by the calf, through the udder-supply arteries, just previous to and after the birth of the calf; and milk in the udder is held up or allowed to flow by contracting or relaxing elastic bands around the teat sinuses. Suspend the question of control by nerve action briefly, and the fact of nutrient blood-flow to the udder, and the positive necessity for increasing its flow to the embryo still exists; for there is no other source than the mammary blood* from which to increase embryo nutrition in pregnant cows. So, contraction in the milk-glands, and in the size of the udder-supply arteries, is a natural necessity to supply an increase of blood, through the placental vessels, to enlarge and continue embryo growth till completed.

But the power of contracting their udder-supply arteries is either suspended or destroyed in nearly all aborting cows, as in nearly all the abortions from evident starvation the embryos are *dead previous* to abortment.

Breeding power is necessary to supply a succession of cows, and constant *increase* in size is a law of embryo life till parturition, and in the animal afterward, till full size is formed. Even the few dwarfed embryos that are aborted alive, making some little increase in size by growth.

But the relaxation of the udder-supply arteries at an excessive and fixed size, and their remaining at a fixed and uncontracting size, as uncontracting tubes, prevents any increase of blood to the embryo, thereby arresting development, preventing any further increase in size, and so abruptly and entirely arresting growth and starving the embryos to death, from the deficient blood supply, resulting from loss of contractile power in the udder-supply artery walls.

The arrest of growth arrests the demand for blood, and

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*As the mammary blood certainly has no innate power to change its course, some contracting force is a necessity, which is supplied by contractile power under nerve influence, determining the direction and extent of the mammary blood-flow, so far as may be necessary to embryo nutrition.

its flow into the placental vessels is consequently abruptly reduced, as the more or less drained and empty condition of the placental vessels sufficiently proves.*

In most cows that abort from mammary artery engorgement, and embryo starvation, the engorged condition of the arteries is continued by the continued excess of blood supply that maintains the large yield; the relaxed condition of the artery walls becoming fixed by long-continued engorgement. A long time must be required to repair the injury to the artery walls, and restore contractile power when the relaxation is considerable or severe, because, as in the case of the udder, expansion distends them to scores per cent *beyond* the natural size, the blood vessels being more widely separated in a much larger area of wall, the proportion of blood supply to area being very much reduced. In like manner the rapid doubling of a cow's yield increases the area of artery wall over 40 per cent, correspondingly reducing the proportion of blood-vessels and blood in the surface area of the artery walls. So the rate of nutrition in the artery walls is reduced as the size of the arteries is increased by engorgement, thus causing chronic relaxation, and postponing or entirely preventing the recovery of artery contraction in many aborting cows. It is this chronic relaxation of their mammary arteries which destroys breeding power in numbers of deep milkers, and suspends the breeding power in many farrow cows that breed intermittently.†

The starvation of the embryos previous to abortion is proved by the evidence:—

1. The fact that nearly all the embryos are dead when aborted proves arrest of nutrition, and consequent embryo death previous to abortion.

2. Several *special* dissections by Dr. Halstead, and care-

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*See Dr. Dalton's Report to New York State Agricultural Society, Albany, 1868.

†See chapter on Farrow Cows.

ful microscopical examinations by Dr. J. C. Dalton,* of both cows and embryos, establish the fact that there is no evidence of disease within aborting cows, or in aborted embryos, while the starved appearance, and emaciated condition of the embryos, and the comparatively empty condition of the placental vessels, afford ample evidence of embryo starvation and death previous to their abortment. While the fact of a degree of fatty degeneration existing in parts of the placenta, shows that starvation of the embryo occurs sometimes, probably days previous to abortment.

3. The observation of numbers of experienced dairymen in the Cheese Factory Districts, for many years—and probably in several States—confirming the evidence disclosed by special post-mortem examination; the observation of this starved or emaciated condition, by dairymen, being very significant evidence.

4. The prevented increase in blood-supply to the embryo from relaxation of the udder-supply arteries, proves the arrest of nutrition, and results in the starvation and death of the embryo, previous to abortion, which is its necessary consequence.

Growth in any organism is increased size, and a constant increase of blood-supply to the embryo calves is a necessity to increase and complete their size, for unless their size be constantly increased, embryo breeding cannot continue, but is arrested, and the embryo dies, making abortment necessary to the cows.

The fact that aborted embryo calves are nearly all starved to death, previous to delivery, being established; and having explained the necessity of cows controlling their mammary blood flow, we here present a table of figures, which is explained in the headings, over each of the columns, our object being to supply the reader

* See Dr. Dalton's report, before referred to.

with a source of reference, showing certain and large percentages of increase in blood, artery size, etc., that take place at the same time, with excessively rapid increase in milk-yield. It will be understood that these estimates are only approximate calculations. But they are believed to be under rather than over the extent of expansion in the udder-supply arteries by increase of blood.

Tables of figures are dry reading, but the subject is so important, that it seems necessary to elucidate certain degrees and rates of increase in blood, and in artery size in this manner.

TABLE.

Time in which 70 per cent increase in blood and yield is made.	Total increase in blood making 70 per cent average increase in yield in 14 months.	Annual increase per cent in blood and yield to make 70 per cent in 14 months.	Twelve per cent, or six-year rate of making 70 per cent increase in blood and yield.	Excess of actual yearly increase over the safe rate of 12 per cent.	Rate per cent in expansion of the artery tubes yearly, to increase blood 70 p. c. in 6 years.	Increase per cent in conveying size of the udder-supply arteries in 14 months.	Rates of excessive rapidity in increase of blood, and corresponding danger of artery relaxation.
14 mos.	48	36	12	24	36	48	24
14 "	60	43	12	36	48	60	36
14 "	72	61	12	49	61	72	49
14 "	84	72	12	60	72	84	60
14 "	96	81	12	69	81	96	69

The process of artery relaxation is explained early in this chapter. We now desire to show certain extreme rates and degrees of the udder-supply artery engorgement, which leads to abortion in many instances.

The expansion of milk-glands and udders of cows by and according to every increase in yield, is apparent to any observer. And when the yield of cows is increased by from 20 to 100 or 120 per cent in a few weeks or months, as happens in various cows in cheese-factory and milk herds, in various localities, the size of the udder is evidently increased to a corresponding extent, the milk-glands being similarly enlarged.

The artery blood from which milk is formed being conveyed to the milk-glands of the udder by the udder-supply arteries, the tubular size of these arteries is increased to the same extent or percentage that the size of the udder and extent of yield are increased. So that when the yield of cows is increased as much as from 25 to 100 per cent, as occurs in many cases in cheese-dairy districts—the increase probably reaching as high as 120 to 140 per cent in some extreme and exceptional cases—the increase of *blood in the arteries supplying the udder* is at the same great rate; and the tubular size of the udder-supply arteries is thus increased by blood engorgement to the extent of from 25 to 100 per cent, within a single grass season of eight or ten weeks, in numbers of cows. So the mammary arteries of some cows are expanded to 120 or more per cent in excess of their previous size within fourteen months, or during the abundance of succulent grass growth, in only two summers, in numbers of instances, when the cows obtain a great and rapid increase of feed.

The danger of relaxation in the udder-supply arteries, and of abortion in dairy cows, is according to the rate or rapidity at which the artery walls are thinned down,* which, as its consequence, is according to rapidity of increase in feed, and blood made from it, in a given length of time. For instance, when a cow's yield is increased 50 per cent in only three months, the danger of relaxing the artery walls by the pressure of engorgement is more than three times as great as when an equal increase is made

* A diagram showing certain degrees of artery expansion is given at the end of this chapter.

in nine months; while in cases of doubling the yield in eight or ten weeks, as is well known to be done in some cases, the danger of relaxing the udder-supply arteries is increased by hundreds per cent over what it would be if sixteen to twenty months were occupied in doubling the yield.

The reason of the greater danger from over-*rapid* thinning of the artery walls, is the reduced and too short length of time for repair, as the rate of renewal by repair in the artery walls is a gradual process, which cannot be hastened, like increase of milk yield. The more rapid the increase of yield, the greater the danger of engorgement and relaxation, and the longer the period required for artery rest, and renewal of the relaxed and weakened walls or tissues. But the time for repair of the relaxed artery walls, by assimilation, is actually reduced and shortened according to the degree of rapidity at which yield becomes excessive, the artery walls being excessively thinned by increased engorgement, and correspondingly relaxed. Hence the danger and liability to relaxation and the tendency to abortion are increased according to the degree of rapidity at which feed, and artery blood, and yield, are increased.

The yield of the cows of Holland was *slowly* increased, their great capacity being only *gradually* developed and established, as any one knowing the necessarily scant resources of the early Netherland settlers, who developed the capacity of Netherland cows—and the careful habits of the German people, must admit.

The "new," or "stranger," cow class, which makes up a majority of the cows in nearly all new cheese-factory districts, though yielding only moderately, are, by far, more liable to abort from artery relaxation than cows that are raised on dairy farms, and have been subject to full feeding from the first. The dairy farm cows are usually fed liberally from their calf-hood up, and if put upon the scant feed that many cows on grain farms receive, such dairy cows would certainly shrink their yield, or flesh, probably both. On the contrary, the "new cows" from the mixed farming country, outside the dairy districts, are subject to very great changes. The quantity of feed the stranger cows receive on coming into dairy herds, particularly into cheese-dairy herds, is a very great increase over the quantity of feed they are previously accustomed to. Besides which, the new feed of those new stranger cows is much of it richer in quality, consisting of corn-meal, shorts, bran, etc.—than such as they have previously received. The consequence is, the new cows eat with great avidity, making a rapid increase in blood, and in yield, as the fact that many of these new cows double their yield in fourteen months* clearly shows. Some of this new cow class are believed to double their yield in eight to twelve weeks, though as a class they are *not* large milkers.

But large yield is not here the question. When cows of only small or moderate yield, that have been previously only scantily fed, double their yield in only a few weeks, or months, as many of the stranger cow class are known to do, their udder-supply arteries are meanwhile engorged, and the artery walls thinned down with as much rapidity as their yield is increased. And the udder-supply arteries' walls in many of them are relaxed in degrees varying in different cows, according to the extent of engorgement from over-rapid increase of feed, mammary blood, and yield in excess of their previous quantity of feed, mammary blood, and yield. It is the excess of increase above their previous yield, whether the latter be small or moderate, which engorges their udder-supply arteries, and the danger of their engorgement increases with

* See Table.

its *rapidity*, because the circulation in the walls of the relaxed arteries cannot thicken the artery walls or restore their contractile powers as much in ten months, as they are thinned and weakened in only that number of days, when a large increase in yield is very rapidly made. Hence the greater liability of "new" or strange cows—the feeding being as strange to them as they are to the situation—to udder-supply artery engorgement, and to abortion, which results from relaxation of the artery walls, and the loss of their contractile power. Accordingly, it is no matter for surprise to find that over 60 per cent† of the Aborting cows in the New York dairy counties are removed from one farm to another; in other words, they are brought into dairy herds from non-dairy farms and small herds. The large and rapid increase in yield by these new cows leads to great and rapid engorgement of their udder-supply arteries; thinning down the artery walls and relaxing them in many cows, and thus leading to embryo starvation and resulting abortments.

Heifers that abort are included in the new or stranger cow class, because from not being milked, nor their udders emptied, they are even more liable to udder-supply artery engorgement and relaxation, than cows that are regularly milked, and have their milk-glands relieved of distention.

The only safe rate of increasing yield, is a very gradual rate say 12 per cent average increase yearly; this increases yield 60 per cent by the eighth year of age, while it is probably quite safe to say that the rate of increase in Netherland or Dutch cows has not averaged 1 per cent increase yearly, for the past sixty years.

It is the very rapid increase in feed and artery-blood, above their previous quantity of feed and blood, resulting

† See Dr. W. H. Carmalt's Report to New York State Agricultural Society, 1869.

from the rash haste in establishing large yield by great increase of feed, that leads to abortion in many cows; chiefly in the new or "stranger" class. To these cows, much and rich feed is a great novelty, and causes great temptation. Their over-consumption of feed leads to an over-rapid increase in their udder-supply of blood, which of course engorges their udder-supply arteries; the weakest muscled and least vigorous cows being most liable to the artery relaxation, resulting from such excessive engorgement in the arteries that supply the udder, which occurs from such rapid rates of increase in food and blood, as are over-rapidly produced during large and excessive degrees of increase in yield, beyond the previous quantity of milk produced.

We here add a diagram, showing various degrees of increase in diameter, or artery-size by engorgement in extents that may lead to abortion in cows under various different conditions, as explained in the references.

In Plate VI., Fig. 1, shows an increase of 70 per cent in artery size made in two months, four months, or six months, as happens in each period in cows, in dairy herds. The diverging dotted lines show the much greater rapidity at which artery-size and blood are increased when yield is increased 70 per cent in two months, compared to 70 per cent in four months, and in four months, compared with the six months rate of 70 per cent increase. The more rapid the rate of engorgement, the more rapid the process of expansive relaxation. In many cows, the udder-supply arteries are already expanded as much as they will bear without becoming relaxed. In such cases, the four, and six months rates of increase are likely to relax, by over-straining the udder-supply artery walls.

The thinning of the udder-supply artery walls, that results from greater engorgement, either in cows or heifers, is shown, though imperfectly, in Fig. 2, where it appears that the walls are thinned down twice as rapidly, and as much, when the blood increases to the same extent in four months, compared with the six months rate of increase and thinning; and three times as rapidly when thinned as much in two months, as happens in some cases, as in six months in other cases or cows. See small Figs. 3, 2, 1, lower side diagram Fig. 2.

In Fig. 3,* read five *years* instead of five months, as the safe rate of increase (see table), or 12 per cent yearly; which doubles yield by the eighth year. This rate of increase in blood, does not thin down the artery walls, (see Fig. 3,) such rate of increase being safe, because gradual and slow, but still much more rapid than in most of the best cows in Europe.

In Fig. 4, *a. a.*, the gradual thickening of the artery walls, according to increased artery-size and augmented blood pressure, is shown; such increase supplying increased power to bear pressure. The *gradual* thickening of the artery walls is an important consideration, for of course greater thickness here is required to bear the increased expansive *pressure* arising from, and corresponding to, the *increase* in quantity and bulk of blood conveyed in and distending the udder-supply arteries, according to any considerable increase in yield, as these arteries—like most other elastic structures—are limited in their power to bear over-strain.

Heifers may rapidly increase their feed and blood, and artery-size, as shown at *r. r.*, Fig. 5, which may relax their arteries, and cause them to abort. And we are informed by a close observer,† that they do abort in as large numbers of cases as new cows, with which the aborting heifers are usually bought, and brought into special dairy herds previous to their abortments.

* The side lines in the Figs. 3 and 4 should widen a little.

† Prof. L. B. Arnold.

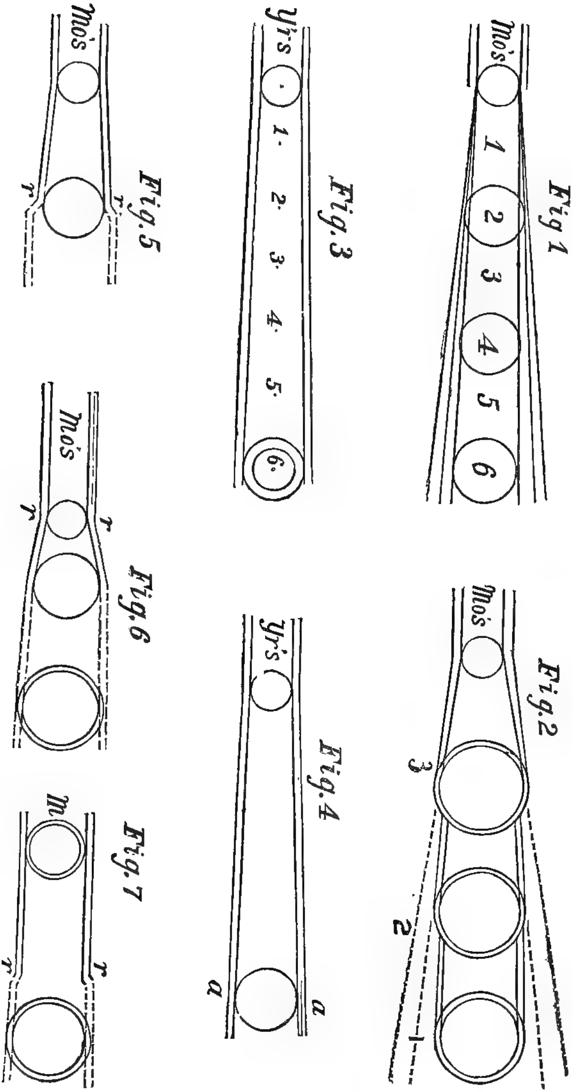

Fig. 1
Mo's
1
2
3
4
5
6
Fig. 2
Mo's
3
2
1
Fig. 3
Yr's
1.
2.
3.
4.
5.
6.
Fig. 4
Yr's
a
a
Fig. 5
Mo's
r
r
Fig. 6
Mo's
r
r
Fig. 7
m
r
r

PLATE VI.

Over 60 per cent of dairy district abortions occur in the stranger class of cows, or newly brought-in cows of moderate yield, in which the yield, of any previous extent, is much more *rapidly* increased than in cows raised by dairymen; see text. The rapid rate of engorgement, and the thinning of the artery-walls, in many new cows, is shown at *r. r.*, Fig. 6; the relaxed condition of the artery-walls, of course, continuing from continued engorgement, as shown by the dotted lines in the same Fig. Home-raised cows are sometimes tempted to eat more feed than is usual, by doing which they increase their blood, and udder-supply artery-size, in correspondence to the increase in yield, as shown at *r. r.*, Fig. 7—which may be 5 to 10 per cent—and this may lead to artery relaxation and abortion in some of them.

Cows are, of course, more liable to artery relaxation, and less likely to recover lost contractile power in their arteries, after mature age and growth, than when they are young and more vigorous.

CHAPTER XXII.

ENGORGEMENT AND ARTERY RELAXATION IN PRACTICE.

Reasons of Abortment at Various Stages of Pregnancy.

The fact is well known that a very large majority of milk cows are fed too sparingly rather than too much; but are *not* over-fed; nor do they have their feed rapidly increased at any time. Accordingly a very large majority of dairy cows are exempt from the abortion trouble. The dairy cows of Ohio are not many of them over-fed, as their excess of yield over that of the ordinary cows of the State is only 35 per cent, or only half as great as the excess of yield by dairy cows in the New York dairy districts. So, from their comparatively small excess of yield, the dairy cows of Ohio are almost entirely exempt from udder-supply artery engorgement in any relaxing degrees. Consequently, abortion is rarely known or heard of in Ohio.

In the coast-country cows of Holland, Holstein, and other parts of Western Europe, abortions are very rare.* Yet the very large yield of many of these coast-country cows is a constant source of admiration to American dairymen.

Why are the udder-supply arteries of Dutch and Holstein cows *exempt* from engorgement, and the cows from abortion, when their yield, and particularly the quantity of blood, and the size of their udder-supply arteries is so much larger than in the moderate-yielding cows of the

* So Prof. Geo. H. Cook, of the New Jersey Agricultural College, informed us after his trip to that country to purchase cows some years ago.

New York and other dairy localities, where the quantity of the blood supplying the udders of aborting cows is much less? The answer is ready: The coast-country cows of Holland, Holstein, etc., have been trained to hand-milking for probably two centuries; but if trained for only 100 years to the pail, supposing them to have begun with a *two-quart* yield, and to have increased their yield only *one pint* yearly; at this small rate of increase their yield by this time would have been 50 quarts, or over *twelve gallons* per cow!

But here it is evident that the actual general yearly increase in the yield of the dairy cows of Western Europe can *not* have been as much through a long period as *half a pint yearly* per cow! This fact, together with the careful habits and scant resources of the early trainers of these large-yielding cows, indicates clearly enough that the yield of these Netherland cows has been only very slowly increased from the small yield of the ancient coast-country cows, their udder-supply arteries having been only very slowly expanded in size and *increased* in their wall substance; but *not* at any time engorged by extreme and over-rapid increase in feed, that certainly precedes large and rapid increase in yield. So the exemption of the large-yielding cows of Western Europe from abortion, is explained by the very *slow* rate at which their capacity for large yield has been developed.

Now turn to Herkimer county, New York, where an average increase of 70 per cent in yield is made in many cheese-dairy herds, in less than two years, and in some cases in a single grazing season; and we see at once not only that such a rapid rate of increase cannot possibly be continued for ten nor even five years; but also that the udder-supply arteries of the cows subjected to this rapid increase in blood must be engorged during much of each grazing season, in many of these American dairy cows.

In the case of Netherland cows, the arteries have been seldom, if at all, engorged, and their walls have been gradually *thickened* and strengthened as blood *pressure* in their channels has *increased;* while the walls of many American cheese-dairy and other cows have been *thinned* down by over-rapid distention, as yield has increased, because the increase of yield has been so *rapid* that the arteries have *not* had even half time enough to thicken their walls by gradual nutrition. This difference between the *rates* of increase in yield in Netherland cows, in contrast with our American dairy cows, shows why the arteries of the former do not become relaxed, while those of the latter are relaxed by rapid engorgement. With this explanation, various calculations that will confirm these views may be readily made.*

The effect of over-rapid increase in yield and artery blood is to thin down the artery walls very much faster than nutrition can strengthen them, thus causing the loss of contractile power, which loss leads to abortion in many cows.

In the table we have estimated 12 per cent yearly, as large a rate of increase as seems safe, because we had in our mind the *very slow* rate of increase in the best dairy cows found in Europe; and in contrast therewith the great number of abortions in our American dairy districts, where the rate of increase in yield has been extremely rapid, particularly in the new cows that mainly compose the herds that supply milk to new cheese factories.

To illustrate the practice that in many cases leads to abortion, suppose that in one, or in several localities, from 100 to 300 cows and heifers are bought up to form or to fill up herds that supply a new cheese factory with

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* See Table

milk, as is frequently done in March, April and May. These cows are only moderate in their yield, because neither dairymen or non-dairying farmers, as a rule, sell their good cows. The heifers bought up are similar to the cows, the best heifers not being sold. Some of these cows have calved; others have not.

When there is grass enough, the factories begin cheese-making. These stranger cows of only moderate yield have formerly been accustomed to poor feed, in scant quantity. As soon as the grass is large enough they are turned to pasture; and, in addition, many herds are supplied with bran, shorts, meal, or other feed, that will increase yield *rapidly*. By the 1st of August many of these "new" cows have increased their yield 50 per cent; some of them double their yield in these three months, or in less time. The size of the udder-supply arteries is enlarged *very rapidly*, and these artery walls are thinned down so very rapidly, by rapid engorgement with blood, that the thinned walls become relaxed by *over*strain, and are *kept in a relaxed condition* by the maintenance of the engorging supply of blood that increases yield so rapidly.

The degree of artery engorgement and relaxation varies in different cows, from various causes. Late in July, or during August, many of these cows are impregnated, the relaxed condition of their udder-supply arteries not preventing impregnation so early after their great increase of feed and blood. The cows eat much more feed, and yield much more milk, and in numbers of them the udder-supply arteries become enlarged as much as 70 to 100 per cent by increase of blood, in only eight to twelve weeks, the average increase in their artery-size being 70 per cent in fourteen months.

These changes in the size of the udder, and its supply-arteries, and the co-incident thinning and relaxation of the artery-walls by engorgement, are not observed or suspected at the time they are taking place.

In almost every stranger or new cow, and in home-raised cows, the degree of increase in size, and extent of relaxation, in the udder-supply arteries, varies. Cheese making, and full-feeding, proceed without interruption till November, or later.

By November, with its dry feed, there is considerable reduction in total yield and the bulk of blood made by the cows; but they are still milked. Some of them do not shrink their yield much, if well fed, though their embryos require more blood nutriment from day to day.

Suddenly several of these new cows that hold out their yield best, abort their embryos, say in the fourth month of pregnancy. Several others abort a month later, holding their yield fairly, if well fed; while the cows that dry up early *do not abort.*

What is the reason of the first batch of abortions, when the yield is fair? And of the second batch a month later? We have space only to indicate the principal, or general causes.

The reason why cows—new cows more than others—abort their embryos in such cases, is because the *embryos are starved to death*, by reason of the udder-supply arteries being relaxed at an enlarged size, causing the conveyance of so much of the mammary blood to the udder, that the supply to the embryo becomes deficient, but cannot be increased, when increase is vitally necessary to maintain embryo life; because the udder-supply arteries, being relaxed, cannot be contracted, nor the supply of blood to the milk glands reduced.

The greater the degree of engorgement in summer, and relaxation in the udder-supply arteries, the earlier abortion occurs, because the larger the share of blood flowing to the udder, the earlier the supply to the embryo becomes in-

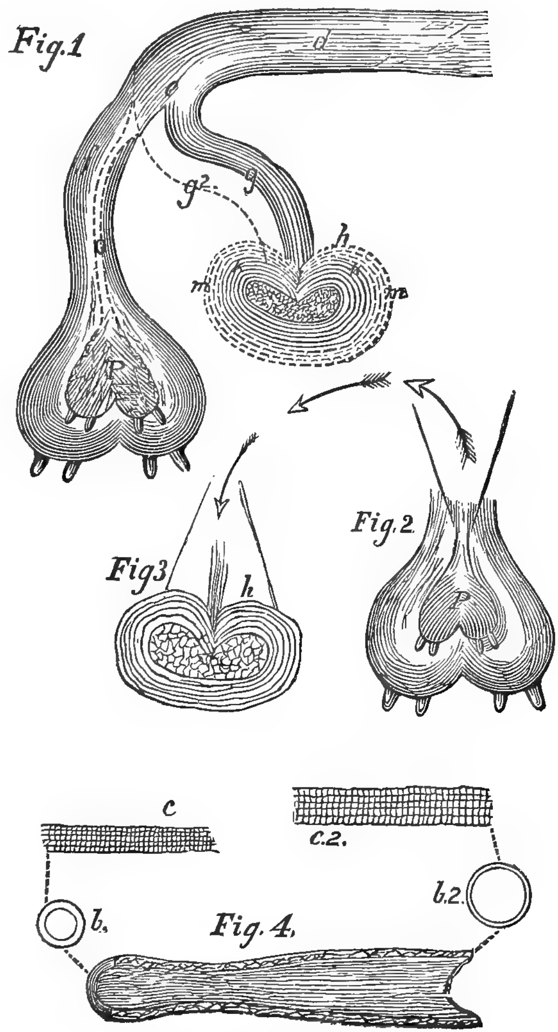

PLATE VII.

sufficient to enlarge or continue its growth. The embryo supply of blood nutrition is not increased, because the blood supply to the udder is not reduced, the power of diverting the udder-supply to the embryo being lost, by the loss of contractility in the udder-supply arteries, in the cows that abort.

The less the degree of engorgement and relaxation in the udder-supply arteries, the larger the blood supply to the embryo; and the longer and later the growth of the embryo continues. The earlier abortion occurs, the greater the degree of engorgement and relaxation of the udder-supply arteries, and the earlier the embryo dies, because its blood supply is not, and cannot be, increased.

As the very large majority of 86 per cent of aborted embryos are *dead* when delivered, we here refer to a diagram illustrating the arrest or stoppage of increase in blood supply, and the arrested growth of the embryos.

As engorgement affects small and large arteries similarly, we assume, for the purpose of explanation, that all the mammary blood flows in the large artery *d*, Fig. 1, Plate VII.,* as far as *e*, same fig., where the branch, *g*, leads to the embryo, *h*. The other branch, *f*, is the udder-supply artery, leading to the udder, *p*. Assume that at about mid-term half the blood flows to embryo, *h*, the other half supplying the udder, *p*. At this time the embryo is about half grown, as at *kk*, but its growth cannot be enlarged, nor even continued, to the full-term size, *mm*, without an increased supply of blood. There is no other source from which an increased supply of blood to the embryo can come than from the blood that supplies the udder through the artery, *f*. But the udder-supply artery, *f*, is relaxed at a much enlarged size; and being relaxed, cannot be contract-

* It will be understood that all the plates are largely diagramatic, and must not be understood by the reader to be anatomical representations of the parts referred to.

ively closed. The artery, *f*, being relaxed, the quantity of blood it conveys to the udder, *p*, cannot be reduced, consequently the supply of blood to the embryo, *h*, cannot be increased. Relaxation of the artery, *f*, prevents its contraction to the dotted lines, *o;* hence the embryo supply, *g*, cannot be increased to *g*2, as is required, to continue its growth to *mm*. Consequently the embryo-growth is arrested at *kk*, and the embryo is starved to death, and aborted at the half-size, *kk*, instead of being enlarged by growth to the full-term size, *mm*, as is required for full-term delivery. The detached figs. 2 and 3, same plate, indicate, by the reversed angles, that to continue embryo growth to the full term, *mm*, the blood supply to the udder, *p*, must be reduced as much as the blood supply of the embryo, *h*, is increased, to continue embryo breeding. Fig. 4 shows a greatly-enlarged and relaxed artery, the walls being much thinned down by an engorging and relaxing increase of blood, as appears in the sections, *b* and *b*2. The relaxed and enlarged portions of the artery wall, or tissue, *c* and *c*2, show the spreading of the artery fibres further apart, very much weakening the walls, as takes place when the arteries are expanded to nearly twice their natural size, by an engorging and relaxing increase of blood, and its expansive pressure against the artery walls.

CHAPTER XXIII.

Characteristics of Abortion Extraordinary.

It Results from Relaxation of the Udder-Supply Arteries.

Abortion from ordinary causes, such as fright, worrying, over-strain, hurts, great fatigue, etc., may take place at any time; but in such cases there are no marks, or evidence of starvation in the embryo, nor in the placental vessels. But in cases of abortion from udder-supply artery engorgement, the evidences of starvation are clear, in the emaciated condition of the embryos, and in the partly emptied and degenerated condition of the placental vessels. This evidence, and its authoritive confirmation by Dr. J. C. Dalton, who states that this disorder does not result from any of the ordinary causes of abortion in man, or in farm animals, excludes the old time ordinary causes of abortion from consideration. And we have accordingly designated this disorder "extraordinary," as it evidently is, because it results from the anomalous and extraordinary engorgement of certain arteries, in distinction from other parts or organs.*

The strong evidences of starvation, already shown as the cause of embryo death, are amply confirmed by the failure of increase in blood supply to the embryos at certain stages of their growth, which has already been explained in Chapter XXI.

Dr. Dalton also affirms† that this modern kind of abor-

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* See page 193—Note.

† See his report published by State Agricultural Society, at Albany, N. Y. 1868.

tion is "not epidemic in New York." Still there seems to be a vague notion in some quarters that it is epidemic. But the only thing in which there is any semblance of any epidemic is, that extraordinary abortions occur in *clusters* of cases, or in numbers of cows together at the same time. Instances of from two to twenty cases have occured together, and may again. The aborting cows, in such cases, frequently reach their head over their pasture fences; the unaffected cows in adjoining pastures, in some cases, even inhaling the expired breath of aborting cows without becoming affected, showing clearly enough that there is no infection, or epidemic in cases of this kind of abortion. In fact this kind of abortion is not a disease, but results from the engorgement and injury of the udder-supply arteries.

The reason and explanation of clusters, or groups of cases occuring together is: the cows that abort together are previously brought into the dairy herds together, or at nearly the same time, and have their udder-supply arteries engorged and relaxed to a nearly like extent, from nearly a similar increase of feed and blood. This increase of blood establishes a similar extent or degree of relaxation, in the udder-supply arteries; which is the predisposing cause, and reason of clusters or numbers of cows aborting in groups or together, as frequently happens in new herds, formed mainly of new cows.

Some persons assign microscopic fungi in the tissues as the cause of abortion; but Dr. Dalton carefully examined in special cases, without finding any such growths. But as it clearly appears that the embryos *die from starvation*, the fungoid theory is alluded to merely to show its inapplicability.

The exemption of farms, herds, and localities, of small or considerable extent, from the affection, is explained by the circumstance of half, three-fourths, or some other proportion of the cows that abort, in numbers of instances, being "new" cows, which are known to be about 100 per cent more liable to abort, than cows that are home-raised. Numbers of new cows that have their arteries relaxed, consequently abort; while on the exempted farms there are probably fewer new cows in the exempted herds, and the cows may not be quite so fully fed, or the quality of the food may be somewhat different. Even a slight difference in quantity or quality of feed, or of increase in blood, being quite sufficient* to exempt the intermitted herds or farms, from such relaxation of the arteries as occurs in affected herds. In such cases, it is the last *ounce*, even a *small* actual increase in blood that engorges; the *last grain* turns the scale; a *slight increase* in degree of engorgement beyond a certain extent, relaxes the walls of the udder-supply arteries, that are already much distended.

Home-raised cows are frequently large in their yield; but they are less liable to abortion, because there is no rapid increase or change in their supply of feed, as a rule. Some few may eat more feed when fed together with *new* cows, and so increase the quantity of their blood so far, if only 5 to 10 per cent, as to *over-strain* and relax their distended arteries, and afterwards abort from such relaxation.

Numbers of herds of large-yielding cows are, however, exempt, because they do not have their feed, or blood, or udder-supply artery size *rapidly* or rashly increased at any time, the rule being that changes in their feed are only *gradually* made.

Heifers are as liable to increase their blood from increase of feed, and to engorge their udder-supply arteries, as cows. But heifers that are treated like exempted cows do not abort, while heifers that are new to the full-feeding, being brought in with new or stranger cows, and having

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*See diagrams, Plate VI.

as much increase in feed, abort in as large proportion to number as the "new" cows of moderate or small yield, with which the heifers are brought in and fed in dairy herds.

Abortion in the dry-feed season is, in part, explained by a great reduction in the total circulation; the cows, in many cases, starving their own tissues, and becoming thin. Concentrated feed, in such cases, makes the blood thicker, but does not much increase its bulk; hence a reduced total or quantity of blood, and a reduced quantity of it conveyed in the mammary arteries to the udder. Still, the *over*-size and relaxed condition of the engorged arteries that supply the udder with blood, are *not* much reduced in aborting cows until *after* the embryos are starved to death, for growth in the embryo is arrested by *non-increase* of blood previous to the abortment.

There are *fewer* cases of abortion in old cheese-factory districts than in new factory districts, as in the old districts and herds, aborting and other poor cows are weeded out; and feeding is much more careful—from dearly bought experience—than in new dairy localities, where everything is new, and little experience has been had.

Cows that have once aborted are far more liable to again abort than cows that have never aborted; as, when cows once abort, they are predisposed by more or less remaining relaxation from the previous distention in the udder-supply arteries, to another abortment at about the *same* period of pregnancy at which the first takes place, by an equal degree of engorgement and an equal increase of blood the next season, to that which relaxed the udder-supply arteries the previous season. The arteries of such aborting cows have *not had time* to recover from their relaxation by the first engorgement, before the next engorging increase of blood again relaxes them, which explains the greater liability of cows to repeated than to first abortions.

No other known cause than prevented increase in blood supply to the embryos, accounts for the sudden arrest of their growth by the stoppage of the placental circulation, and the consequent death of the embryos; nor for the evidences of the embryos being starved; nor for the clusters of abortions that occur together; nor for the greater liability of "new" cows and heifers to abort; nor for the greater liability of cows to second, than to first abortions. But the certain engorgement of the udder-supply arteries from over-strain, which is as certain as the increase of blood, itself, by over degrees of rapid engorgement with blood, accounts for, and explains all these extraordinary and peculiar characteristics as the necessary result of over-rapid increase, in feed, blood, and artery expansion, in degrees that lead to the *loss of contractile power* in the udder-supply arteries, thus preventing increase of embryo nutrition, and causing embryo death, and so making abortment a necessity.

CHAPTER XXIV.

Summary of the Argument on Abortion,

As the result of Embryo Starvation from the Engorgement and Relaxation of the Udder-Supply Arteries.

The preceding argument in detail, with the evidences, and illustrations, together making a sufficiently complete demonstration, the following conclusions are connected in a series of links, completing the chain of argument, in preference to giving a summary of the chapters :—

1. The extremely rapid and large increase in yield, by aborting cows, necessitates an equally large and rapid previous increase in blood, and in the size of the arteries that convey it to the udder.

2. The engorgement and great expansion of the udder-supply artery tubes with blood from rapid increase of feed, being abrupt, the resulting over-strain of the artery-wall tissues is equally abrupt and extreme; the over-strain causing relaxation by discohesion in the degree of the excessive strain from engorgement.

3. Engorgement and its over-strain, thins down the artery walls in degree according to increase in their tubular size, by over-rapid distension from too rapid increase of blood, and its pressure.

4. The engorging supply of blood to the milk-glands, continuing to maintain yield, the large size at which the udder-supply arteries are relaxed is maintained by maintaining the large bulk of blood and yield; thus keeping the relaxed arteries as full and as much over-strained as at the time of their relaxation.

5. The thin and relaxed condition of the artery-walls becomes more or less chronic or permanent, in many cows, the arteries losing their natural elasticity by prolonged inaction, from loss of contractile power, their enlarged size becoming fixed, from assimilation in their walls during the continued engorgement, while they are too thin and weak to contract.

6. The size of the udder-supply arteries, when relaxation takes place, varies in different cows. But the enlarged artery tubes convey much more than the previous quantity of blood to the milk glands; the necessary supply of blood to the embryo being correspondingly reduced by the unnatural increase in the udder-supply, thus reducing the source of embryo nutrition, by increasing blood flow to the udder.

7. At some stage of embryo growth, or enlargement, the reduced or fixed supply of blood to the embryo becomes insufficient, because, being fixed by artery relaxation, in cannot be increased, as the size of the udder-supply arteries, and the supply of blood they convey to the milk glands, being fixed, cannot be reduced.

8. There is no source from which embryo nutrition, or growth, can be increased, except by diverting a sufficient, and constantly increasing quantity of the large and fixed blood supply flowing to the udder, into the ovarian and uterine artery channels, to thereby increase the placental circulation, and so increase the nutrition required by the embryo.

9. The deficient, non-increasing placental circulation is also fixed by the over-strain and relaxation of the udder-supply arteries, there being no increase in the total of mammary blood, unless the cow starves her own tissues. Hence there can be no increase of blood nutrition to the embryo, except by, and in proportion to, some reduction in the udder-supply of blood.

10. The laws of embryo life require a constant increase in growth and size, and a corresponding increase of nutriment to add to and enlarge size, so increasing embryo growth—which is always enlargement by assimilation of an increased blood supply to the embryo.

11. The mammary blood is naturally provided and circulated to form and increase embryo growth, the two sets of mammary arteries being located and adapted to one succeed the other in use, the uterine set supplying the embryo previous to birth; and the udder-supply set supplying the milk-glands for the calf, after its full-time delivery.

12. The division of the mammary blood to supply both the embryo and the milk-glands at once does not increase its total quantity, so the embryo nourishment must be deficient whenever the supply is too small to enlarge embryo size or growth. Hence, *growth* by increased nutrition must *cease,* unless the placental circulation be increased according to increasing size and demand of the embryo.

13. But the supply of blood to the embryo *cannot* be increased, the only source of increase being the udder-supply, which can*not* be reduced, as the engorged size of the udder-supply arteries remains fixed and *un*diminished, by reason of continued distention and relaxation. In this way the *effect* of the udder-supply artery engorgement is embryo *starvation.* And abortment follows as the necessary alternative, to prevent the death of the cows.

14. Nearly all the aborted embryos are dead previous to delivery; their appearance, and that of the aborting cows, showing no marks of disease, but clear evidences of embryo starvation, both in the drained vessels of the placenta, and the emaciated or starved appearance of the embryos when delivered.

15. It is daily twice demonstrated in the pail, and

continued large udder-size, that the udder-supply of blood is not reduced, and for that reason there is no increase of blood or nutriment in the embryo-supplying arteries. Nor can there be an increase of blood devoted to that purpose, while the relaxed condition of the udder-supply arteries continues. The demonstration here concluded supplies in detail, the reasons why udder-supply artery engorgement leads to embryo starvation from arrest of nutrition, and the necessary miscarriage, or premature delivery, and other consequences, as explained in other chapters on the subject.

CHAPTER XXV.

Failure of Aborting Cows to Breed.

Accidental Engorgement of the Uterine and Ovarian Arteries.

Sometime during the year 1871, or 1872, the owner of an extensive cheese factory,* and a herd of good Ayrshire cattle, was troubled with a case of abortion in an excellent Ayrshire cow, that soon after her miscarriage came rapidly into heat, and coupled, but she did not become in calf, and the heated condition recurred four or five times in succession, the cow still failing to breed. Happening to meet the proprietor of the herd, he consulted us, and we recommended isolation and quiet for the cow. Afterwards, he informed us, that isolation did not lead to breeding, for the heat and coupling frequently recurred. This circumstance led us to distrust the efficiency of quietude alone in allaying the coupling heat, that comes on frequently, without leading to pregnancy from coupling, in numbers of cows that have aborted.

Since that occurrence we have devoted much time to observation, inquiry and meditation on the subject, with the hope of being able to explain the reason of the repeated recurrence of coupling heat, and the failure of the aborting cows to breed.

The disordered organs, in such cases, cannot be inspected; hence, we are restricted to circumstantial evidence, and to reasoning by comparison. Still, though positive demonstration is impracticable, there are conditions and

* Mr. Chester Hazen, Wisconsin.

facts in such cases that enable us to draw conclusions that are mainly consistent, and probably trustworthy.

The heated condition which leads to coupling, for instance, would not come on without an increase of blood and heat in the region of the ovaries. Nor would coupling recur so much more frequently than at the normal intervals, unless there was a recurrence of abundant blood in the region of the ovaries, as frequently is the case when this accidental coupling heat comes on in cows, after they have aborted.

The peculiar circumstance in cows that have recently aborted is: They come into heat in a few days—from four to ten—after aborting, which is contrary to natural rule; as the cow species breed only once a year, naturally, and do not come into heat for several weeks after calving, or until they are capable of breeding, which is generally about the time the calf's teeth are grown, and hard enough to enable it to graze. Then, milk being no longer demanded by the grazing calf, the cow dries up, and the milk-forming blood, not being demanded at the udder, the blood supply and heat about the ovaries are increased, bringing on heat, or œstrum in the natural way, and at the natural period.

In aborting cows, on the other hand, coupling heat comes on in a few days after they abort, which, in different cases, varies all the way from the third or fourth to the seventh or eighth month, the coupling heat occurring in a few days after such premature delivery; this preliminary condition of breeding, thus occurring in and invading the current breeding season, even as far back as the middle of a current and unexpired breeding term. So the heat that comes on early and *suddenly* after an abortment, occurs at various premature periods, or by from one to six months earlier than breeding begins again, in cows that carry their calves to full term; this arising from a disordered condition of the blood circulation, giving rise to such accidental heat and premature coupling, or coupling entirely out of the normal season.

How, or from what circumstances does this premature coupling, and the false heat that leads to it, arise? This is a pertinent and important question, and requires as consistent and reasonable an answer as, under the circumstances, it may be practicable to give.

When cows abort at *any* period of pregnancy, from udder-supply artery engorgement—as explained in the chapter on that subject—the demand for blood nutrition by the embryo is abruptly terminated by the premature expulsion of the embryo and placenta from the breeding organ together. The demand for blood nutrition for the embryo being thus suddenly terminated by abortment, a rapidly-produced condition of engorgement in the uterine and ovarian blood-vessels is the result.

In any case of abortment, after the third or fourth month, the degree of engorgement arising from the suddenly arrested flow of blood to the embryo, must be great in extent in the ovarian region. But, when abortion occurs about the fourth month, or later, the glut of blood that engorges the uterine and ovarious blood-vessels is increased, according to the *lateness* of the period at which it occurs, and the size of the embryo when the abortion takes place—the degree of engorgement being according to the size of the embryo, because the quantity of blood whose flow is arrested is according to the size of the embryo when its demand for nutriment suddenly ceases from abrupt abortment. It appears certain, then, that when abortion occurs as late as the middle of pregnancy, as happens in many instances, the extent of engorgement by a sudden glut in the blood-vessels of the breeding organ, and in the proximate vessels of the ovaries and oviducts, must be extreme, and of course must lead to other and further results, that are as abnormal as is the occurrence of abortion itself. In other words, while abortion, at an advanced stage of pregnancy, certainly causes engorgement in the blood-vessels of the *breeding organ*, this condition of engorgement must lead to several other equally abnormal and unseasonable consequences.*

The first and most immediate result of engorgement of the blood-vessels surrounding the uterus and ovaries, is a certain, but variable degree of relaxation in the walls of the arteries, and their capillaries, which results from their sudden and extreme distention, causing more or less relaxation from this extreme over-strain by engorgement. The natural outlet for the blood-flow toward the uterus, being thus cut off by abortment, blood accumulates in, and greatly distends, the uterine artery vessels; which takes place very rapidly. This glutting process continues until the uterine blood-vessels become engorged and distended to the extent of 50 to 100 per cent, probably much more in some instances, in which engorgement from abortion occurs. The consequence is, the thinning of the uterine and ovarian artery walls down to the extent of 50 to 100 per cent below their natural thickness; and this result must consistently ensue in the small capillary vessels as well as in the larger tubes of the uterine system of blood-vessels!

The natural outlet and demand for the blood that thus accumulates in and engorges the uterine and ovarian blood-vessels, as just pointed out, being cut off, no means of immediately relieving the engorged vessels appears.

* It requires about two weeks after full-time delivery for the uterus to contract to its ante-breeding size, and as much as two months to restore it to the ante-pregnant condition, by involution. In almost parallel cases, the weakness and disorder resulting from abortion continue for a *long time*, in some instances; and it is highly probable that the disordered condition of the uterine and ovarian organs and blood-vessels, in cows, continues so long as to become *permanent*, when the degree of engorgement in the uterus and ovarian blood-vessels is so abrupt and extreme as it certainly is in many cases of abortion.

Concurrently with the engorgement of the uterine and ovarian blood-vessels, a much thinned condition, and corresponding state of relaxation, in the capillary walls of the uterine blood-vessels results; and the enlarged size and thinned walls of the capillaries must continue for a length of time proportioned to the degree of expansion and relaxation, so making the reduction of the engorging quantity of blood in the uterine and ovarian blood-vessels, a *slow and prolonged process.*

When coupling fever occurs at the natural season after full-term delivery, it results conditionally, or from the presence of an increased amount of blood, and blood heat in the ovarian blood-vessels. And the presence of coupling fever soon after the accidental engorgement that abortion leads to, indicates the presence of augmented blood and heat about the ovaries, from accidental engorgement. It is no matter for wonder, therefore, that coupling fever comes on in cows soon after abortment. Nor is it a matter for surprise, that the relaxed condition of the uterine and capillary vessels, caused by engorgement, becomes more or less chronic in numbers of cows.

The active circulation of the blood in the ovarian vessels continues as long as the engorgement, but the large increase in their contents seems to account for the increased quantity of heat, and its continuance in large supply in the increased quantity of blood.

The pathological condition of the ovarian vessels and organs during accidental engorgement, is not, however, clearly ascertainable. The occurrence and frequent recurrence of coupling soon after abortment, indicates that there is either a long continued, or frequently recurring accumulation of heat about the ovaries; the excess of blood certainly continuing for a considerable time.

Physiologists state that ova are maturing at all seasons, as may be necessary to make impregnation possible. But it is scarcely consistent to infer that mature ova are abundant in the midst of a breeding term, when a large amount of blood is required by the embryo. Ova are abundant after calving at full term, when there is much less demand at the uterus for blood. Hence matured ova are probably *few* during pregnancy, and much more abundant after full-term delivery ; and fewer still after an abortment, some time previous to full term. We are limited to conjecture, in such cases, as to why aborting cows repeatedly fail to breed, after single and repeated recurrences of heat and coupling. But there is *certainly* a much disordered and feverish condition of the uterine and ovarian organs. There is probably also an irritated and *inflamed* condition of both these parts.

The repeated recurrence of this accidental heat, in a degree that leads to coupling, is the result of a more or less prolonged continuance of the condition of engorgement, or its recurrence in the blood-vessels around the uterus and ovaries, as already intimated. This engorgement probably continues a longer or shorter period, according to the degree of artery *relaxation;* and is likely to be greater, and to require more time for its reduction, the larger the embryo and its blood supply are at the time of the abortment. And the greater the extent of relaxation from engorgement around the ovaries, in any given case, the longer the local excess of blood must continue ; and the number of recurring heat periods and couplings will usually correspond.

That the accidental presence of more blood, and blood heat, about the ovaries, leads to coupling from this excess of active blood-heat, seems highly probable. A *generally disordered condition* of the uterus, and ovarian parts, resulting from abortion, is *certain.* There may be resulting degeneration in the oviducts, or these tubes may possibly be closed by the compression resulting from the irritated and swollen condition of contiguous parts. And even if ova are impregnated, they may not adhere to the walls of the breeding organ, as the latter are liable to degrees of ulceration, leading to the formation of pus, while there is probably an escape of blood from the relaxed capillary walls into the genital and other cavities, as shown in some cows, by bloodlike discharges.

In fact, it is evidently impossible that abortment at an advanced stage of pregnancy could take place without producing a much disordered and injured condition of structure in the uterus, and in the proximate ovarian organs, and such conditions may continue for months.

It may therefore be inferred that the disordered state of the ovarian organs prevents impregnation, or that the disordered condition of the uterine walls prevents the ovarian attachment in the uterus that is necessary to breeding, either of these disordered conditions being sufficient to prevent breeding.

The discharge of blood through the genital passages, that is sometimes met with in cows, occurring each time they repeatedly come into heat after aborting, is evidence of a greatly disordered condition of the genital organs and vessels; and the relaxed and weakened condition resulting from abortion, and consequent engorgement, sufficiently accounts for the escape of blood from its natural channels into the genital passages; and though we cannot of course precisely explain how any such particularly disordered condition, so evident and certain, in several proximate parts and vessels is produced, it evidently results from the greatly disordered condition of the uterus, brought on by abortment, and the accidental engorgement of the numerous uterine and ovarian blood-vessels.

Accordingly, the secondary and accidental engorgement and artery relaxation, which leads to unseasonable heat and coupling, during a current breeding term, necessarily results from abortion, as its originating and abnormal cause; and the chief matter for surprise is that any aborting cows should be able to breed during such a greatly disordered condition of the breeding organs, in the midst of an unexpired breeding term.

A probable reason why some aborting cows breed, is their aborting early in pregnancy, and then sustaining less injury, because their embryos are small, and there is less engorgement in the uterine and ovarian blood-vessels from a lesser degree of distention. Some cows, from weak digestive power, produce only a light supply of blood at any time; others have strong constitutions, and can bear much derangement of their breeding organs, with less injury than weaker cows sustain. Whatever the minor differences in degree of injury or in the exact locality of its occurrence may be, it is certain that great disorder and injury in the uterine and ovarian organs results from abortion, and the relaxing engorgement it leads to in the uterine region.

This secondary engorgement is itself abnormal and accidental, the coupling fever arising from it being also abnormal and out of season. And, whatever particular displacement, lesion, or degree of disorder, or combined influences may prevent impregnation in such cases, the failure to breed is due to one or several of the greatly deranged and unhealthy conditions, into which the uterine parts and blood-vessels are precipitated by the severe disorder resulting in the uterus from abortment, and in the ovarian organs from the engorgement, of which unseasonable delivery by aborting cows is the immediate cause. So that abortion itself, in many cases, apparently suspends, impairs, or destroys the breeding power, and the future usefulness of cows that are much injured by prematurely and abruptly aborting their embryos.

CHAPTER XXVI.

PREVENTION OF ABORTION IN COWS.

Resting Them, and Other After-Treatment.

When the natural power of any organ or part in an animal is weakened or impaired by overtaxing its strength, rest, to give nature's resources a chance to act, is the only alternative offering hope of recovery, by the restoration of lost strength. And, although from the nature of abortion, resulting as it does from *over*-strain, or extreme and rapid rates of expansion and thinning of the udder-supply artery walls, by engorgement, there can be *no immediate* remedy or cure for the resulting relaxation in the artery walls; still, there may be a degree of recovery of lost contractility, in some cases, when artery relaxation is not too severe.

In another chapter, the well-known fact that farrow cows do recover power to breed, after breeding power has been suspended temporarily, is explained. In their case, the artery walls *slowly* regain contractile power during rest, by the restorative influence of slow nutrition, long continued.

The older cows are when the injury by relaxtion takes place, the slower the reparative process by the circulation, or, more correctly, by assimilation; bodily activity, and the rate of circulation, both being reduced as age advances. Consequently the chances of recovery are greatest in young cows. When heifers abort their first embryos, they should be dried off as soon as practicable. But as the conditions of primary breeding, such as fully mature ova, and a sufficient supply of breeding blood to continuously sustain embryonic breeding, rarely concur till two months after full-term delivery, heifers that abort should *not* be allowed to couple till six or eight weeks after the expiration of full-term. This interval allows time for considerable recuperation, or recovery of strength and contractility in the relaxed artery walls, by assimilative repair.

In nearly all cases, the less rapidly cows dry up their yield, the more their arteries, and sometimes their milk-glands and udder-sacks, are relaxed, whether this weakened condition has been brought about slowly or rapidly.

If heifers or cows abort early after pregnancy, their udder-supply arteries are probably relaxed severely, and the injury has most likely been rapidly inflicted. Hence, when either heifers or young cows abort before the sixth or seventh month of pregnancy, they should *not* be allowed to couple till from *three to nine months* after the expiration of full term. If they abort before the middle of their term, they should *not* be milked for about ten or twelve months.

The principle is the same as to over-strain in the udder-supply artery walls, as in the human wrist, instep, or other parts; the greater the injury, the longer the time required for repairing it, the more time required for rest. When abortion, resulting from artery relaxation in cows, takes place before mid-term, the relaxation of the artery walls must certainly be severe, as the blood supply to the embryo fails at an early period, showing great expansion of the udder-supply arteries, and that these arteries do not contract, as they should, when the embryo requires an increase of blood nutrition, as indicated by the feeling of hunger impressed on the nerves of the cow.

The chances of young cows recovering full contractile power, after extreme engorgement and relaxation of the udder-supply arteries are greater when they abort late, after the sixth month, for instance. In such cases the degree of artery relaxation is probably not very severe, and three to six months rest, after the expiration of full term, may result in the recovery of full breeding power, and the previous milking capacity.

But—as a matter of opinion—we doubt the propriety or safety of ever again subjecting any cow, whatever, *to very full feed* after she has once aborted, earlier than the sixth month of pregnancy.

This is a topic of such importance that it must lead to much discussion, and also to close investigation, which we have neither space nor time to engage in at present. Hence we are restricted to the less certain sphere of opinion, based on probabilities.

Resting our views on this basis, supported by analogy, we advise:—

1. That neither heifers nor cows be allowed to couple, in any instance, after aborting, until eight weeks *after the expiration of full term*; as, though there may be abundant heat, one or more of the necessary conditions of breeding may not exist.

2. When either heifer or cow aborts from udder-supply artery relaxation, before the sixth month of pregnancy, coupling should be prohibited until six months after the expiration of full term.

3. Neither cows nor heifers that abort before the fourth month of pregnancy should be allowed to couple in less than nine months after the expiration of full term. It is to be understood, also, that a moderate amount of feed, for several weeks after an abortment, is much safer than full feeding. The quantity of feed should be reduced considerably, forthwith, after miscarriage, to prevent the engorgement of the uterine and ovarian blood-vessels; and to preclude, as far as practicable, the long delay of recovery that

must result from continuing full feed, and the engorged condition of the uterine blood-vessels.

Moderate feeding only, should be allowed until after the expiration of full term, and always after an abortment; and the cow or heifer, in any case, should be dried up as soon as praeticable after an abortment, to allow of the thickening of the artery walls, so to promote the recovery of contractility, if possible, by resting the udder-supply arteries.

As already stated, we doubt the propriety of feeding any aborting cow as fully as other cows that have never aborted, are fed. In other words, it appears to us that the arteries which have been once over-strained and relaxed by engorgement, should not again be so fully distended with blood, as a degree of blood pressure equal to that which previously relaxed, might cause a similar degree of overstrain, relaxation, and abortion a second time.

This is the reason why moderate feeding, and less blood and blood pressure seem desirable in cows that have once aborted.

It is safer on the whole to employ aborting cows for breeding only, afterward, if they are good milkers, and well-formed cows, likely to breed good calves, as they can be kept separate from the milk herd, *fed moderately*, and *their calves allowed to run with them*, and take *all* their milk; as when the udder is kept nearly empty by the frequent sucking of the calf, there is *no back-setting* of the blood in the udder-supply arteries; while moderate feeding prevents these arteries being excessively distended with blood. By such management, cows that have once aborted may be used for breeding heifers with advantage, as thousands of cows that have never aborted, and are rarely or never hand-milked, do in the large herds and open ranges of the West, where it is much more profitable to use cows for breeding than for milk only. And, certainly, if it be profitable to breed calves at all, it is most profitable to breed as large calves as can be raised, by letting them take and convert all the milk of the cows, so forming large growth; for, in nearly all cases, calves can consume all the milk their dams yield, so making large growth instead of small size.

When inferior cows abort, the best course is to fatten them, unless they are known to bring good calves, as sometimes may happen.

Preventing Abortion.

We have shown in preceding chapters that the relaxation of the udder-supply arteries results from an over-rapid and excessive increase of blood; that such rapidity of increase in blood corresponds to increase in yield; and that very rapid increase in yield is therefore attended with great danger of relaxing the arteries that convey blood to the udder. It has long been a maxim—derived from the experience of successful feeders and dairymen—that *changes in feed should never be rapid or great in extent,* the sufficient reason being that either increase or reduction of feed causes a similar increase or reduction in the quantity of blood in the circulation, thereby causing corresponding changes in the extent of artery blood in steers and store stock; and an increase or reduction in yield corresponding with increase or reduction of feed and blood in milk-yielding cows. The point to be especially considered is:

That when feed is increased very rapidly, the increase of blood is about as rapid; and that when the arteries are very rapidly engorged with blood, their walls or tunics are liable to be thinned down and relaxed, thereby losing the power to contract, from which loss of contractile power abortion results, as explained in chapters on that subject. Moderation, when increasing feed, should therefore always be practiced, as even with store or fattening cattle, rapid increase in feed cloys, and puts animals off appetite, causing temporary indigestion, and sometimes evident shrinkage of flesh.

In milk cows, though there be a greater demand for blood, and for food to form it, the limits of safe degrees and rates of expansion in the arteries of different cows are soon reached. We have stated, in the table, the safe rate of increase in yield, and in udder-supply artery capacity, and quantity of blood, at 12 per cent yearly, in young cows till the age of maturity; and by reading the chapter on "How Good Cows are Produced," and parts of others—see introduction—the treatment necessary to prevent abortion will be understood in principle and detail.

Over-rapid and extreme rates of increase in feed or blood, and consequently in yield, has originated the abortion trouble; therefore, the only apparent alternative treatment which can prevent abortion, is in the conservative direction of slow change; or moderation in degrees of increase in feed; more steadiness in carrying out the motto, "Excelsior," making less haste to get large yield, and thereby increasing the certainty of achieving that end, by exercising more caution and care. Such a course invites fewer risks, accidents, or catastrophes, that are at once costly without advantage, and cruel without necessity.

That a moderate course in feeding cows or increasing their feed is best, is consistent with the motto of Seneca, and, according to ages of experience by the people of Holstein and Holland, where, from the necessity of the case, large yielding capacity has been but very *gradually developed*, by only *moderate increase of feed*, extending through long periods of time.

The most simple causes are usually least suspected and last discovered, as in the case of abortion. But the dairymen of the future may congratulate themselves in having the means of preventing any such widespread and heavy losses as have heretofore been sustained from this disorder, fully under their control. The preventive means consist in substituting prudent care for rash haste, precluding loss or alarm by preventing miscarriages, so saving the cows, and thus largely increasing the certainty and profit of dairying; also remembering that to be forewarned is to be forearmed, that prevention is better than cure, and that in order to prevent, it is necessary, to know the reason why. Considering these facts, dairymen will probably benefit themselves much more than the author by extending the circulation and encouraging the perusal of this work, particularly the chapters relating to abortion extraordinary, and kindred topics.

CHAPTER XXVII.

Farrow Cows, and Intermitted Breeding.

Weakened Contractility in the Udder-Supply Arteries.

A sufficient supply of blood in the region of the ovaries and the oviducts, is of course necessary to supply the blood and heat from which the coupling results in cows at any season of the year. But the intermission of breeding during alternate years or longer periods, by farrow cows, is so peculiar a circumstance, that it cannot occur without an equally peculiar cause; and, after careful study and inquiry, the conclusion is arrived at, that partial relaxation of the udder-supply arteries is the cause of these intermissions of breeding power, during one or more years, in farrow cows. Rest in the breeding organs is necessary to allow the cows to recover sufficient contractility in their weakened artery-wall muscles, to enable them to again become fit for breeding.

In farrow cows, the relaxation of the udder-supply arteries is light in extent; yet the enlargement of these arteries is sufficient to preclude the augmentation of blood, and blood heat in the ovarian blood-vessels, in the degree that can give rise to coupling heat. Too large a proportion of the blood is conveyed by the enlarged and partially relaxed udder-supply arteries to the milk glands, to admit of a sufficient blood-supply to induce coupling heat being diverted to the ovarian blood-vessels, to excite their natural functions of activity. This accounts for the failure to breed in a succeeding season, of cows that bred in the previous year; the partially relaxed udder-supply arteries requiring *time for rest*, and recovery of their weakened contractility.

Many farrow cows yield more than an average quantity of milk, and half of them probably are owned by persons keeping only a few cows. In such cases the best yielders become pets, and are frequently treated as such, by extra or special feeding, chiefly with bran slop, or scalded cornmeal pudding, etc. The rapid increase of blood from too large supplies of such feed, probably engorges and relaxes the udder-supply arteries in such cows, that are already yielding largely, their arteries being already distended up to the full limits they can bear without relaxation. In this condition only a slight increase of feed and blood may relax the artery walls in degrees that will require one or two years' rest, to give time for the relaxation to disappear, by the recovery of lost degrees of contractility in the artery-wall tunics. In such cases blood and artery size are perhaps slightly increased, together with yield.

The artery walls, during the intermitted season, have time to thicken by nutrition; and by thickening, regain sufficient contractility to enable the cows to breed the second or third season, by contracting their udder-supply arteries so far as to divert enough blood, and blood heat, to the ovarian region to bring on the natural coupling heat, or œstrum, which leads to impregnation, from pairing.

In most farrow cow cases, however, the large yield, being resumed at the next calving time, is continued or increased, the relaxed condition being soon again reached by the increased pressure of increased bulk of blood, to form yield, so that but few farrow cows ever again become regular or permanent breeders after one intermission; many of their number permanently failing to breed after one, or perhaps two, successes in alternate seasons.

If it is particularly desirable to have a farrow cow breed again, the only way is to dry her up, so that the udder-supply arteries may regain their contractility, if the relaxation be not too severe; but the extent of injury, or the probability of recovery, can only be determined by trial of this course. The better and only safe course is, very *gradual* increase in *feed*, and in blood made from it; in artery size and udder supply; and in udder size and milk yield.

When yield is only *gradually* augmented, the artery walls gradually gain strength, and maintain their contractility; and injury to either udder or arteries is prevented by the maintenance of contractile power, as is natural to both; and indispensably necessary in the udder-supplying arteries, to prevent the suspension or permanent loss of breeding power in the cows that are so profitable while in milk, because their full yielding power is established. But it is not best nor even safe to exceed the natural power, as the udder-supply artery engorgement has limits, which are easily reached, and beyond which it is not safe to experiment in the way of increasing milk yield.

When farrow cows do not come into heat at their usual season, while still continuing their usual yield, they should have their yield reduced, by taking less and less of their milk, if their breeding be desired, till coupling heat appears. When, by steadily reducing their yield, they at length come into heat, this is the consequence of an increase of blood in the vessels contiguous to the ovaries. And this condition of heat can be induced earlier, by an earlier reduction of yield, and of blood supply to the milk glands, by which course the supply of blood to the region of the ovaries is increased. In this way farrow cows may resume breeding earlier, from earlier drying.

In nearly all instances farrow cows are those that have been petted and fed with moist feed, or specially prepared mixtures well adapted to distend the digestive organs with food, and the udder-supply arteries with blood, and the milk glands with milk; the over-distention in either organ not being so extreme as that which culminates in abortment; but still the over-strain is sufficient in extent to cause partial relaxation of the udder-supply arteries. And this limited degree of weakening by over-distention and partial relaxation may be sufficient so prevent the necessary supply of blood and blood heat to the region of the ovaries, to bring on coupling fever.

During a season of rest, contractility in the weakened arteries is partially regained, a sufficiency of blood again flows towards the ovaries to bring on coupling heat, in some cases, and breeding may be resumed. Thus the intermitted breeding of farrow cows is accounted for by the occurrence of partial relaxation in the udder-supply arteries.

CHAPTER XXVIII.

Failure of Deep Milkers to Breed.

It results from Chronic Relaxation of the Mammary Arteries.

We have seen questions relating to the difficulty of drying certain cows, generally deep milkers, and asking advice through the agricultural press, in several instances; and, also, numbers of such cows. They are scattered over the country, and consist, chiefly, of cows of large yield, that are dried up only with great difficulty; and there are some cases in which such cows cannot be dried, without reducing their feed almost to starvation rations. In such cases it is quite clear the cows have lost control over their mammary blood flow; their udders are, most of them, relaxed, while their udder-supply arteries are large in the extreme; and as certainly relaxed, because it is very evident they do not contract; and therefore the blood-flow to the udder is not reduced, or diminishes but little, and slowly, and does not cease, as it does in cows that dry themselves by artery contraction while they are breeding. It is evident, therefore, that those cows which cannot be dried early, and do not breed, are affected with chronic relaxation in the arteries that supply the milk glands with the breeding blood; the flow of which to the udder is not arrested.

These cows of deep yield cannot be easily dried, because the large size of their udder-supply arteries remains fixed by relaxation. The arteries cannot be closed at the

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natural time, or in the natural way, however strong the instinctive or natural tendency of such cows to breed may be, because these arteries are incontractible, in consequence of being relaxed in the muscular tunics.

The failure of such deep and long-yielding milkers to breed results, also, from the relaxation of their udder-supply arteries. A certain but variable proportion of all the blood produced by digestion is required to nourish the cow's individual system. Any surplus remaining is naturally breeding blood, provided for the breeding function.

Continuing a large yield, long, but at the same time not breeding, nor coming into heat, is a certain indication of most of the breeding blood being conveyed to the milk glands; and the reason of the continued flow in that direction, is that the arteries that supply the udder with blood do not contract; not contracting because they are relaxed to such a degree that their contractile power is either much weakened or lost.

Not having power to contract, or if any, not sufficient to cause such a supply of blood and blood heat, in the ovarian circulation, as is required to produce the accumulation of heat that causes coupling fever. The blood and heat supply in the ovarian vessels thus failing, the heat that would naturally bring on coupling does not appear, nor occur. So there is neither impregnation, nor the heat that leads to it, because the uterine circulation is reduced and delayed in such large degrees, by the continued large supply of blood, and its heat together, to the udder, as to render the providing of a sufficient quantity of blood and heat to give rise to the œstrum, is impracticable; hence the failure of deep milking cows to breed is directly due to reduced blood-supply in the uterine and ovarian circulation, and primarily to the relaxation of the udder-supply arteries at the greatly increased size that conveys so much of the mammary blood to the milk-glands, that the supply to the ovarian vessels is too small to induce coupling.

It is quite likely that these non-breeding deep milkers are, many of them, the same cows that previously bred only once or twice in alternate seasons. But this is not important, as they are permanently disabled as breeders when their udder arteries remain greatly relaxed. When deep milkers fail in breeding power from a single instance of engorgement of their udder-supply artery-tubes, the expansion is extreme, and most likely takes place at or before midsummer, when they are not pregnant; and also when the great abundance and juiciness of tempting grass feed leads to excessive consumption; the effect being a great increase in the bulk of blood produced, as is clearly evident by the doubling of the udder and artery-size in some of such cases, in the short period of 6 to 12 weeks in different cows. The extreme distention of the arteries that supply it at the time of maximum yield, is as great as that of the udder, and the painful effects of extreme distention of the udder, when long continued, are frequently too evident to be disputed. And it is certain that great pain in such cases results from actual injury to the udder structure; the nature of the injury in the milk-glands probably being that of discohesion, from extreme tension, or overstrain, in the fibrous substance of the milk-glands. And this overstrain or extreme distention being increased or frequently repeated, probably leads, in some instances, to permanent relaxation in the milk-glands, also in the udder sack; and, at the same time, in the arteries that supply the udder with blood; the relaxation in each case being, of course, due to an over-supply of blood in the udder-supply arteries; the over-supply of blood in such cases being the result of rapid increase in feed, or over-feeding.

The breeding arteries of cows are limited in their containing capacity, if their contractility is to be maintained, and unless artery contractility be maintained, breeding power must be impaired to the same extent that artery contractility is weakened or suspended.

Contractility in the udder-supply arteries is the power by which cows dry themselves. It is, also, the power by which they are enabled to breed, by controlling their mammary blood-flow, and diverting it to the embryo, which would be impossible, without contractile power in the udder-supply arteries, that enables cows to carry on and to complete the process of embryonic breeding.

When cows are advanced in age, as deep milkers usually are when they can no longer breed—breeding power being lost by chronic relaxation of their udder-supply arteries—their recuperative power is so much reduced that recovery of breeding power cannot be reasonably expected. And, perhaps, no better course can be pursued than to dry them by reducing their supply of water, by reducing the moisture in feed, or in any way, to a minimum allowance, and fattening them after they become dry. Such cases are not very numerous; still it is desirable to reduce their number, which will become less, when the cause and origin of the trouble is better understood, to aid in which these explanations are made.

CHAPTER XXIX.

Alternate Milking and Breeding with Cows.

Maintaining Large Yield by Selection and Inheritance.

The size of milk cows generally is small, and in the dairy localities and districts—excepting some old home-raised herds, or families of cows—the size is not much larger; as mostly the *new* dairy herds are formed by gathering up such cows as may be for sale, in the non-dairying parts of the country. A chief reason why many cows are small is: They are raised from small calves; and as calves are the *basement story* upon which the future cow is built, the size of the cow ultimately corresponds with her previous size as a calf. Small calves are chiefly the result of *dwarfed* growth in the embryo, previous to its birth and breathing as a calf. The cow race can be continued in no other way than by breeding. Milk itself originates in the last stages of the breeding process, and is provided to continue the breed, by maintaining the calf till it becomes able to gather its own subsistence. Mammary or udder-supply blood is produced and conveyed to the udder to provide milk for maintaining the calf; and, being a *special* supply for supplying the demand of the offspring, the blood from which milk is formed may correctly be called *breeding blood.* The ovarian and uterine blood-supply, provided to sustain the ante-pregnant and embryo stages of breeding, is also breeding blood; and the effective cause of calves being small is: The supply of breeding blood to the embryo is so small that it cannot grow fast or become large, and therefore makes only a small extent of growth, or a dwarfed size, according to the small supply of nutrition it receives. As the embryo cannot make growth without breeding blood, its extent of growth can only be in proportion to its supply of nutriment. Digestive power is limited by two conditions: First, by extent of space or size of the stomach and alimentary canal to contain the crude substances that supply the crude material of blood. Second, by the quantity of digestive or solvent fluids which, being derived from the blood, cannot exceed their natural proportion to the quantity of blood supplying them. The quantity of blood derived from a given amount of feed cannot exceed the quantity of blood elements, the use of which depends on the digestive power, which varies according to the muscular vigor and extent of exercise and *breathing*. The total blood supply is according to two sources of natural demand: First, to nourish the system of the cow; and, second, to develop and maintain the three breeding stages or processes aforesaid. The instances are exceptional and few in which cows produce more blood than is required to nourish their own systems, and also to continue their kind, by providing blood and blood heat, and to supply blood nutrition during the preparatory and embryo breeding processes; and to form milk also to continue the embryo growth in that of the calf. And it is certain that embryos can and do in very many cases receive and organize *all* the breeding blood—all that residue which is not used in nourishing the cow's system; and afterward, as calves, consume all the mother cow's milk.*

When embryo calves receive all the breeding blood—as when pregnant cows are not milked—they grow much larger, according to their larger supply of nutrition, be-

* Some Short-horn breeders, understanding this fact, have for generations allowed numbers of their cows to suckle their own calves; and, in some cases, two common cows supply one Short-horn calf.

fore full term, than the calves of cows that are milked either close or late during their pregnancy. And when calves get all the cow's milk, as in many thousands of instances in the cattle-breeding sections of the West and far West, they grow as large in six months as average-yearlings in dairy sections, and in States further East and North,* which clearly shows that less than full nutrition does not make full-sized calves. We call attention to these fundamental facts to show why cows are generally small, namely: Because their breeding blood is divided between two opposing demands, satisfying neither in full. Half the breeding blood can only make half-sized† embryos and calves, through the supply of the placenta or the udder. And small or only half-sized calves can rarely develop into good-sized cows. In brief, the size or extent of calf-growth is certainly limited to the extent of calf-nutrition, and small calves make small cows; and so cows become small from limited supplies of nutrition and limited growth in their embryo and calf forms, or during their earliest stages of life.

True, some small cows yield much milk, but this is the result, in part, of inherited forms, and additional increase of such forms, by long-continued demand for milk at the udder, and long-continued distention of its supplying arteries aided by activity and good digestion. The pro-

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* On our own small stock farm, and others much larger, in Plymouth Co., Iowa, many such cases are met with.

† Dr. Henry Tanner. Professor of Rural Economy, Queen's College, Birmingham, England, says in the Journal of the Royal Agricultural Society: "The animals which breed with least difficulty yield the best supplies of milk, and produce the most *healthy and vigorous* offspring." * * "We have suffered them to deteriorate in value as *breeding* animals by the *decrease* of their *milking* capabilities." * * "*A short supply of milk* is indicative of enfeebled breeding powers." Prof. Tanner is incorrect in these statements, for milking pregnant cows withdraws the blood devoted to forming milk, from the support of the embryos, by diverting it to the udder, so reducing the means of embryo nutrition, and lessening the power of cows to breed either vigorous or large calves. When any increase of blood is used to form milk, the products of digestion are diverted from the breeding organ, thereby *weakening* breeding power by withdrawing blood from the breeding process, the result in many cases being dwarfed calves or starved and aborted embryos.

portion or disproportion, the peculiar form of many cows of large yield, seen in their large hind quarters, is developed gradually, and at the expense of their general growth during their heifer-hood, or growing years; as after full growth there can be no material increase in general size, nor much change in their form of frame.

We may explain a little further the origin of large hind quarters, and large udder. The increased size in the hind quarters of itself shows that large yield, by small cows, is at the expense of their general growth, as the full natural size and proportion of the fore quarters would be maintained, if the blood-supply and its nutrition were there in their full, natural proportion. But limited digestion cannot supply unlimited demand; the demand at the pail being unlimited, while the natural demand in the fore quarter, or half of the cow, for blood nutrition, is evidently not fully supplied.

The larger size in the hind quarters of milk cows of any size, but met with mainly in middle-sized cows, with large udders that yield well, is due primarily and principally to hand-milking, which, with special supplies of similar feed, enlarges the milk yield.

As continued yield evidently results from special feed, and demand at the pail, we confine ourselves to intermediate results:—

1. Increase of feed leads to increase in the bulk of blood from which milk is formed; and the increase of blood is in the same degree that the bulk of milk-yield is increased to, both results, of course, being according to increase of feed and its digestion. To save labor and time in milking, the udder and glands have long been used for the temporary storage of milk, in semi-daily supplies; the twelve-hour yield being stored in the udder, and taken at one milking, instead of being drawn at four or five times by the calf. When drained by the calf, the udder is kept small and

undistended, and remains of small size. But by long continued storage of a twelve-hour yield, the natural small size of the udder has been greatly expanded and enlarged. And since the commercial demand for milk products led to the increased demand for milk, special dairymen have largely increased the size of the udder, by increasing the yield of their cows. This illustrates the expansive effect of milk, and its pressure on the size of the udder, as a store tank or reservoir.

Now as to enlargement in the hind quarters: The blood is continuously forming by digestion, being colored and completed vitally by breathing. The rate of blood production varies with the rates of breathing and nutrition; and blood production constantly continues in a less or greater degree, the tissues of the cow receiving their nutritive supply continually. But the blood that supplies the udder is not constantly in use, and flowing like that which nourishes the tissues of the cow. The milk-glands receive blood and form milk at certain seasons only. After calving, a large increase of blood takes place in the udder-supply arteries from which the milk-glands regularly receive their supplies. The milk-glands admit the milk-forming blood till they are full; there is then a back-setting process, by which the arteries are further distended in size. They are also increased in length to some extent, and in the extent of their convolutions and ramifications; and probably also in the number of their smaller branches. In this way the concurring effect from increase of blood and milk storage in the udder, is to increase the tubular or containing capacity of the udder-supply arteries as much beyond the natural, or previous size, as the yield of milk and the size of the milk-glands and udder are increased; the enlarged supply of blood for forming milk necessarily requiring an equal increase in the artery space, which it fills and occupies, previous to passing to the milk-glands.

There is a large venous proportion of blood that does not enter the udder; but this also temporarily fills artery space; and it is safe to say that the space filled and occupied by the mammary artery-blood is increased generally as much or more than yield is increased. And when yield is gradually increased, during three or four years in heifers, and so on through several generations of their successors, a very evident increase in the size of the hind quarter results from the increased extent of space filled by the increased blood-supply; and increased ramifications and size of the arteries containing it, previous to its entering the udder.

In the embryo the circulation commences before the formation of the frame, to convey the frame-forming material. But in heifers, or young cows, previous to maturity, the increased extent of the artery tubes, and of the fluid and solid substances within them, gradually expand the dimensions of the frame-work and size in the hind quarters, and at the same time the length, size, and strength of the bony frame and its connections are correspondingly increased by nutrition, from the general circulation.

So special demand at the udder leads to large increase in the contents or substances of the correspondingly increased space occupied by the mammary arteries and their contents; thus expanding the general size or dimensions of the hind quarters, and so contributing to establish large yield by forming—in effect—a blood reservoir near the udder.

It requires constant perseverance, in careful feeding and close milking, continued through several generations of heifer cows, to develop and establish the best forms, found in milking families of good cows; and it being desirable to establish them, it is equally desirable to continue them by descent and inheritance, which is practicable, as experience has demonstrated in establishing such forms in various families of cows.

With the vast expansion in dairying, many more good cows are required than are or can be produced by the hap-hazard general practice of breeding indiscriminately alike from good, bad, and indifferent animals.

Experience shows that general farmers, or non-professional cow-breeders, certainly will not breed the best class of milk cows, and if they accidentally obtain such a cow, or family, they either demand very high prices, or keep them as family favorites. It therefore devolves upon dairymen and breeders to supply such cows, if they are to be bred or multiplied; as certainly is required, in considerable numbers.

Dairymen and breeders own many of the best cows that are available, for special selection to breed from. A limited number may be obtained by good judges, from general farmers, for beginning such herds. But—to repeat—milking pregnant cows, is strongly adverse to their most successful breeding; for, as before shown, the largest and most profitable embryos and calves are, and necessarily must continue to be, produced by devoting all the breeding blood of breeding cows to its natural purpose, which is forming increase in the embryo growth, and calf-size, according to increase in production of blood and milk.

On the contrary, breeding reduces the supply of blood to the udder; the entire milk-yield being formed, not from the general circulation, but from the mammary supply of the breeding blood arteries.

It follows that full, or good success in obtaining large yield, and breeding full-sized calves, while milking pregnant cows, is impracticable and impossible.

Besides insuring successors of large yield, a great saving of labor must result from keeping only good cows. And the saving of labor is an equivalent of profit. Two good cows yield more profit than three poor ones; besides which, the hap-hazard practice of breeding is neither scientific, systematic, nor progressive.

Good but small families of milking cows have been established in numbers of instances, at times, in different parts of the country, showing that it is practicable. But while most breeds of cattle supply cows of good form, the question of breed is not particularly involved, as the right form of organization, and the necessary yield-basis of good digestion, are the necessary conditions required in cows for large yield; and two-thirds of the time occupied in gradually establishing a small milking family can be saved by breeding from cows that already have good yielding capacity.

There are several methods by which cows of good yield and form can be employed to breed a much larger succession of similar cows than is now extant: First, either small or large herds of *good* cows can be divided,* and each half used in alternate years, one-half for breeding and the other half for milking. Or, if a smaller proportion or number will keep up the numbers of the herd, one-third of the cows can be bred from each year, another third succeeding them the next season, and so on, which would employ all the good cows of each herd one-third of the time, or one season in three; this method affording time for the breeding organs to rest and recuperate during the milking season or seasons, and resting the parts immediately accessory to milk-yield during the breeding terms, which would certainly be beneficial to the milking and breeding powers of the cows.

Modifications of this system are practicable. For instance: Well-formed heifers can be employed for milking three or four years to increase their capacity, and the peculiar form which in most instances co-exists with large

* By the use of barbed wire, which we know will make efficient cattle fences, the cost of fencing being very light.

yield. By the sixth or seventh year, with suitable feed and care, full milk-production will be reached, as then the size being full, becomes fixed, and the capacity which size gives can no longer be increased, with rare exceptions, in which cases the breeding power* is sometimes suspended or destroyed. After maturity the cows can be used alternately for breeding and milk-yield, as long as their yield is profitable.

Men of large means and facilities can divide their herds between dairying and breeding, which affords good facilities for raising the calves from the best cows, by employing light milkers to suckle them, as repeatedly is done.† In fact, there is no reason why the breeding of dairy cows should not become a special pursuit in this way, or by some modified system. For instance, breeders who prefer that business, might carry on their art in cheese-dairy districts, and select good calves from the *best cows* of dairy herds—many *good* calves being destroyed—and raise them for use as dairy cows, with their light-yielding cows, which are many of them *very good breeders*, in this way giving dairymen the use of their cows soon after calving. We briefly suggest, being firmly convinced: First, that breeding and milking cannot be most profitably or successfully carried on at the same time with the same cows. Second, that it is desirable and practicable to breed milk cows from those of *established yield and good form.* Third, that this can be most successfully accomplished by some system of alternate milking and breeding, with known good cows. Fourth, breeding should be the special business of cows, for the time being, to prevent a reduction in their size and capacity; size with muscle being the measure of power, whether for breeding or milk. Full size in cows is maintainable only by raising full-sized calves. And the acquired do-

* Read chapter on Farrow Cows.

† Short-horn and other breeders understand this practically.

cility of the best cows is not an unimportant characteristic to secure by inheritance, where so much handling is necessary. In conclusion, it is certain that selection is but little practiced, and that multitudes of inferior cows are used for milking, because the supply of cows of good capacity and form for milk-yield is very much less than the demand.

It is also evident that the demand for good cows can never be supplied by the present hap-hazard, take-them-as-they-run practice of forming many dairy herds; and it would be certainly profitable in several ways to introduce improved methods in breeding cows, in consistency with what has already been done in the many improved methods of treating the numerous and various products of the milk that the food and breeding processes in cows necessarily produce.

CHAPTER XXX.

Examples of Large Yield, and How it is Produced.

Practical Suggestions on Handling Feed, and Training.

Much has been, and will continue to be said and written about the influence or indications of points, and forms, and breed in milk cows, but the general conditions of activity, feed, and climate in which they are raised, control the general size and digestive capacity of cattle. And cows that develop more than average capacity, either as breeders, or feeders, in any set of conditions, are there the best cows. The naturally developed capacity is the foundation or origin of excellence in all our domestic animals. And this natural excellence being noticed, the animals showing it are selected to breed from; and this is the origin of small families of cows, some of which multiply into extensive breeds, and take their name generally from the country or locality in which they are first selected. Hence it is clear that name or distinction of breed has no influence on the peculiar growth which gives peculiar capacity; as good form and capacity depend upon exercise, or training, more than on inheritance.

Special training, for instance, originates peculiar form, as large hind quarters, in most cows of large yield, and the form cannot be maintained by inheritance, unless the training, that originated it be also coutinued.

Large hind quarters having been alluded to, we may say that they appear principally in cows of moderate or small size, that yield well; and result from a general increase of blood, and in the size, length, and convolutions of the blood-vessels in the hind quarters; through a number of years, or during several generations, perhaps, if the feed and close milking giving rise to this tendency be continued, the increase in bulk of blood and blood-vessels occupying an increased space; the blood being thus increased in the hind-quarter region, ready to supply the milk-glands.

Thus the blood-flow toward the udder enlarges the muscular extent and vascularity of the hind quarters, which naturally leads to increase in frame growth, to support the augmented bulk and weight of blood, blood-vessels and muscle, and other augmented substances, in the larger hind-quarter growth. And it is apparent that large frame growth, and depth in the hind quarters—whether the fore-quarter growth corresponds or not—is important in the form of milk cows, as without the necessary space in proximity to the udder, for containing a large supply of blood, the necessary quantity of blood to supply a large yield cannot be present near the udder. It may be that strong breeding instinct, which through the nerves certainly controls the blood-flow in certain parts, as in drying up the udder by diverting blood to the embryo, induces a larger flow of blood to the vessels of the hind quarters. Be this as it may, the blood must occupy space, and when near the udder, is available for increasing milk-yield. A large net-work of blood-vessels in the upper twist shows that, in such instances, there is much blood in the vicinity of the udder. We must repeat here some remarks on form, and other points. A light head, neck, tail, and bones, indicate a light demand for blood in these parts, leaving a larger surplus than if such parts were large, to increase the milk-yield. This is their signification, instead of the mystical influence that some writers and cattle dealers ascribe to them.

A narrow face generally accompanies a long, narrow form of body; but this form—popular with some—is a sign of weak muscles and weak digestive power; the digestive power depending much on muscular action, from inlet to outlet, and being weak or strong according to the strength or weakness of the muscles generally. The muscles of the top ends of the ribs are frequently weak in such cases, causing flat sides from the weight of the abdomen, constantly drawing the lower ends of the ribs inward, thus causing flat sides. The whole muscular system in tall, narrow-faced, flat-sided cows is weak, as shown in their languid movements and dragging gait. A *round*-bodied, open-faced, comfortable-looking cow, with good-sized hind quarters, and a springing, lively step, is a good form of cow of any size, because she has the indications of large digestive power.

As several English and American writers, and others, attach much importance to looseness of the skin over the hip bones, and upper back ribs, it may be explained that when the skin is not tight here, it must be loose and movable generally, as the great weight of a large belly draws the skin down more and tighter over these bones than on any less projecting parts. Hence, if the skin be mellow and easily lifted over these bones, it must be generally mellow and movable. To the foregoing add a coat of thick, fine hair, and a skin that is medium, or thick, according to previous exposure, with a good sized *yield-mark*—no matter what its form, so that it be large—and we have the general form and indications of a good cow, whatever the name of her breed may be.

The right form results from the influence of feed and training; and, though transmissible, it can only be maintained by suitable feed, training, and care. A pleasant expression in face and eye is the index of good temper, which can only be maintained by such care and kindness as develop affection toward the attendant. Yes, affectionate attachment, ye machine men. Comfort promotes good digestion, and tends to increase yield. Caressing, comfort, and care, as well as feed, having had each its share of influence in developing large yield, as is frequently witnessed, and as was long ago shown in the training of the Netherland cows of Western Europe, now attracting great attention from American dairymen.

The Netherland, or Holstein-Dutch cows are a large breed, and large in their yielding capacity. They are bred in various parts of the low-coast country, with unimportant differences in color, etc., from Holland to Denmark. Formerly breeds of cattle in North America were mainly derived from the British Islands; and the cattle of that country were derived, previously, from Western Europe, where dairying is an ancient art, thus indicating that the Netherland cows, generally, are the oldest well-known dairy breeds. It follows that their milking capacity, which varies as in other cows, with locality and treatment, has been longer continued, and is more fixed, as far as fixing a suitable organization is concerned, than in any other known dairy cows.

The form of the Holsteins, or Dutch cows, however, is *not* perfect, nor the best for pasturing in hilly or undulating localities. They are rather too tall, standing higher, for instance, than the Herefords or Galloways, or than the best common cows. They are not round enough in body, as whatever may have been said about double cubes for beef, and wedge-shaped cows for milk, a round-formed cow is the most vigorous from superior muscularity, and has better digestive power, producing more blood, with a better form for economizing heat, and a larger body-surface compared with her weight, than tall and somewhat flat-sided cows. And roundish-bodied cows will yield more when their hind quarters are large, other things being equal, than those that are less round in form.

The flat-side form is developed on comparatively level surfaces, where there is but little side-strain on the muscles, while the round form is developed where the surfaces are undulating; the reasons for which are given in another place,* as we have here to trace out several of the leading influences that have established larger yield in the Holsteins and similar Netherland cows.

First, the atmosphere of the Netherlands is very moist, containing much watery vapor, the natural moisture of the air entering into the composition of all roots and grasses grown there, in a larger degree than takes place in dry climates. In this way the feed is made more succulent, as well as more bulky, than the more concentrated feed produced in dry climates; thus leading to a larger bulk of blood, in supplying an equal extent of nutrition in their feed to the cows. For this reason, the bulk of blood formed, and the bulk of yield derived from it, is greater in cows raised in moist climates, than in those raised in dry climates. This is one source of greater quantity in their yield.

The greater amount of watery vapor in the atmosphere, together with the greater amount of moisture in the soil, also causes a much larger proportion of moisture, probably amounting to several thousand gallons a year, to enter the blood of a cow by way of the lungs, as watery vapor in the air she breathes; which is another source of increase in bulk of blood, and one that is much less available in dry climates. Both those influences have their share in making up bulk in the yield of cows in moist climates. There being a larger bulk of blood, to nutritive value, the excess of bulk from excess of moisture leads to increase in the size of the arteries, and the total quantity of blood entering the tissues, and in the vessels of the entire circulation,

* In remarks on California Short-horns.

which accounts for considerable excess in bulk of yield generally in the Netherland country cows.

Selection of the best, which are generally most petted in feeding, also had its share in collecting and concentrating the best herds of cows, in the best natural grass districts, where, of course, dairying becomes most extensive and concentrated in any country.

The great industry, pains-taking care, and close economy of the people in the Netherlands, in the management and training of their cows, has much increased their yield, the cows being milked very close, the demand for milk being alway greater than the supply. This practice tends to develop the largest yield that can be made, without reducing flesh. Add to this, their pasturing in the night time, and blanketing to prevent loss of blood-heat by evaporation, and we have quite an effective series of influences contributing to increased bulk in the yield of Netherland or Holsteins, and Dutch cows. And the long succession of generations through which these influences have operated, has led to the large size in the hind quarters, and arteries, and in the udder and yield-marks, to correspond, being more fixed, by long use, and inheritance, than in any other example, or country, in so many cows.

Considering the more watery and less nutritive quality of the native feed in the low-coast country, we should of course expect the Netherland cows to be more remarkable for the quantity, than the quality of their yield, according to the distensive influences already stated.

Cows that have large digestive organs and artery systems will supply as much, and richer milk, when a richer quality of feed of equal bulk is supplied to them. But this will not, in this country, generally be done, in all probability; hence some reduction in yield, in our dry climate, by imported cows of this breed, and in their descendants, is probable.

We believe bulk of yield can, however, be maintained in these cows, and developed or increased in others most effectually by a continued supply of moist or succulent feed, because this is consistent with the causes that have led to the large yield in the cows of Holland and Holstein.

The same is also true, to a considerable extent, of Ayrshire cows, the county of Ayr being low, and having a humid atmosphere, thus supplying similar influences, leading to large yield in this neat dairy breed.

We believe that in good grass latitudes, the grass of low moist soils will be generally found to produce the largest yield in cows of any breed; the quality of yield being a different question from that of its bulk or quantity.

From what we have seen in many instances, in developing large yield, the use of thick slops tends strongly in that direction. The several stomachs of the cow afford large space for bulk and digestive action; and this shows that bulk is required in their feed; and in the best old dairy districts, the feed and air have a large share of moisture in their composition. Hence the view that bulk may best be increased by increasing the proportion of moisture in the food of cows, from which bulk or quantity of yield is derived.

The moist consistency of the solid droppings of cows, compared with those of horses, swine, and sheep, seems to agree with this view; certainly it shows that in cows the contents of the bowels are much diluted with moisture.

How best to accomplish this object, with a view to increasing yield, is a practical question for cow keepers. We consider it very important, however, that the mixture of the moisture with the solid parts of the food be as intimate as practicable. This intimate mixture is the reason why succulent root-food, such as bagas, beets, and carrots, promote health and thrift, by diluting drier feed in the stomach and bowels. Of course succulent grass needs no addition of moisture, but in the fall and winter, the feed of cows, in milk, should be brought as near to the consistency of grass, as practicable by the infusion of moisture.

In feeding cheap grain, or corn, we should prefer to grind rather fine, and mix the meal with chopped hay. First steep the hay or chaff in warm water for a short time; then drain off the moisture, and put chaff in manger, and then sprinkle on the meal. The reason for using *warm* water is that it is absorbed more rapidly. Feed should be cool when fed.

In bringing chaff or any other dry feed to the consistency of grass, slow steaming is a good method, and need not be costly. We should prefer hay to short chaff, as hay must be masticated, which is important in changing starch to sugar, and in preparing food for close digestion. Meal sticks to and mixes with damp feed. Some cows may be able to dilute their dry food to a moist consistency by drinking water at the *right time;* but frequently they do not get water when it is *most* required. If the moisture be supplied in the food, there can be no loss in yield from want of moisture to increase the solvency of the food.

There is so great a demand for cows of large *yield* that if *all* the *good* cows in the Netherland country were obtained, they would not supply it. Hence we are endeavoring to show how good milkers are produced.

Much effort in feeding to increase yield is being made. Indeed, in Illinois they are talking about raising the yield to 6,000 or 7,000 lbs. of milk per cow in a season. Dr. Tefft, of Elgin, is said to have had a cow—in 1879—that yielded 12,000 lbs. of milk in one, and 11,000 lbs. in another season. This indicates an engorging excess in blood and yield, that results from treating the cows as though they were machines. We expect several consequences to result from this policy. The breeding power of cows forced to such monstrous yields will be certainly destroyed in many cases. The dairymen will be unable to keep up such vast yields, because they lose the use, as breeders, of their best cows. Many of the cows will soon be worn out, and, at length, over-sanguine dairymen will come to be satisfied with a yield equal to that of the best cows in the moister climates of Europe, say with 4,000 lbs. of milk per cow in a season.

Home-bred cows must be mainly relied on for the dairy, because there is no other source that can supply the vast and increasing demand. Home-bred animals have the advantage of being already acclimated, as well as being accustomed to the dryer feed of our inland climates. We have seen many single cows of very profitable yield, and numbers of small families of like character, in different North-western States. And there are many instances of the kind the country over, showing that American home resources are of suitable character. And this is as true of feed as of cows.

There are hundreds of specimens of the poor man's cow which have developed large yield from very simple treatment, with only limited facilities, the *training and care* being similar to that which, as we have explained, produced the best cows in Western Europe or in North Britain.*

As to quality of food necessary to produce milk, it is established that fatty or oily feed is *not* the most favorable† for that purpose. One reason against fatty feed is:— The fat of milk is formed by the transformation of other and different substances—the nitrogenous proteids—by cell-

* An unfailing test of an easy milker is *flat* ends in the *teats*. Cows having flat-ended teats milk easy, the outlet being large; those having *pointed* ends to their teats milk *hard*, because the outlet is small, and much squeezing is required to force out the milk.

† See Foster's Physiology, p. 301.

action in the milk-glands, while if the fat of milk were supplied ready formed, there would be no transformation required in producing fat in the milk.

Sweet feed, such as sugar cane, is not safe, because too much sugar—as shown by Prof. Tanner, of England—endangers the breeding power. Experience shows that grass, either green and succulent, or dried, is the best and therefore the standard milk-producing feed. Clover, from its containing much nitrogenous matter, is also very good for milk. Taking the composition of grass for a standard, it can be readily ascertained which kinds of feed approximate it in their quality. Millets, if cut and cured when green, may be available to increase the supply of fall and winter feed. Of all the auxiliary food, corn fodder, both when green, and when dry, is probably the best and most economical. We have repeatedly used it green for feeding swine in hot weather; and cows relish it exceedingly, consuming it also with avidity after it is dry. In all ordinary seasons and soils, and in most parts of this continent, corn fodder can be raised in abundance, and cured in small shocks. And then the shocks can be made large, and when well made and tied, they can stand in the field all the winter, ready for use, without danger of spoiling the fodder. But corn-stalk sap contains so much saccharine matter that fermentation and moulding very soon occur, when it is stacked or housed in much quantity; so it is best not to stack it, but to keep it in large shocks of ten to fifteen bundles each *in the field,* in the North-western States.

In regard to quantity of yield, that quantity which can be made while maintaining the *strongest digestive power* is most economical for any cow or dairyman.

The quantity of milk-forming ingredients, or elements, in food of any kind, is limited, and cannot be increased by the digestive or milk-forming processes. A certain extent of digestive and milk-forming power will transform the milk constituents from a certain quantity of feed. Hence two cows cannot make any more milk from an acre of grass or a ton of hay than three cows can produce from the same amount. If ten bushels of wheat will produce only 42 lbs. of flour per bushel, no more can be got from it by grinding it with two pairs of stones, than by grinding it with three sets. Hence, as far as cost and quantity of feed are involved, no particular advantage appears in immoderate yield. No particular reason appears why a ton of hay will not supply as much milk by feeding it to three cows yielding four gallons each, as when fed to two cows yielding six gallons each. A man with only room enough for one cow might prefer a six-gallon yield on that account. But, of course, providing there is sufficient room for a greater number of cows, we do not see why cows of moderate size and yield cannot get as much milk out of any size of pasture, or any known quantity of hay or other feed, as cows of very large yield.

On the other hand there are certain objections to immoderate yield. Over-feeding weakens digestive power and brings on dyspepsia in cows. Digestion is the basis of yield, and much milk-forming material is left in the droppings, when digestive power is much impaired by over-feeding, to induce excessive yield.

Breeding power is also weakened in many cases, or suspended, as we see in farrow cows;* in other cases, breeding power is entirely destroyed; thus destroying or impairing the value of good cows, for breeding successors. It is also difficult to dry cows whose breeding power is weakened, and they are slow and unprofitable in fattening.

When pregnant cows dry up their yield readily, at the proper time, and breed large calves, their yield is not excessive. But if they dry up very slowly, and breed small

* See chapters on Farrow Cows and "Deep Milkers."

calves, their breeding power is impaired by previous overfeeding, and excessive yield, or its incidental consequences.

On the whole Senecas motto, "A medium course is the best," is good. It is also true that "haste makes waste," for instance in increasing feed and yield too rapidly. And, as no more milk can be formed from feed—plus water—than its milk-forming elements can supply; cows of fair yield, for their size, can supply as much value in milk, and more in other ways, without risk of loss, and maintain their value and yield permanently; but this result is not attainable with immoderate yield or weakened digestion.

As cows become attached to kind attendants, it is not best to change these, or "swap horses" during the milking season. And there is probably no better way to obtain a full and enduring milk-supply, than by selecting roundish, active, comfortable looking cows, full or large in their hind quarters; and then do good, and have mercy, *i. e.*, handle the cows tenderly, and carefully; feed them moderately, and regularly, with suitable feed; and increase feed and yield only a very gradually; sheltering the cows from extreme cold and wet, and giving them regular, moderate exercise to develop yield, and maintain appetite and digestive power; so preserving the value of the cows for breeding, for beef, or for milk, while securing a permanent and profitable yield of sound milk for the pail.

GENERAL INDEX.