



LXII. The law of the nutrition of animals pointed out

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ciently describ'd to any intelligent Person," is rendered by "In hac autem Epistola Methodus Fluxionum idoneo harum rerum cognitori evidenter satis describitur." If not from carelessness, this version arises from an intention, that no foreigner might see the assertion that Newton had written on Fluxions to the comprehension of any intelligent person, mathematician or not. Perhaps some may think that the word *intelligent* had not then obtained its modern signification of general power of understanding. Perhaps it had not, quite: but that the thing was monstrous, even at the time, is made evident by a contemporary writer, who certainly did not strain at gnats, finding this rendering rather too much of a camel. Raphson it was who, in his history of Fluxions (printed both in English and Latin), showed his power of going all lengths by declaring his belief that Leibnitz had discovered Newton's *cipher* (which we all know was not a cipher, being only the letters of a sentence placed in alphabetic order), and thereby discovered fluxions. But rather than print the assertion about an intelligent person, he adopted the Latin as the original, and printed an English translation of his own, in which, instead of "to any intelligent person," we read "to any proper judge of these matters."

The more the whole matter is looked into from its beginning to its end, the more will the evidences of reckless injustice thicken about the inquirer. The Newtonian partizan may find a poor consolation in balancing the sins of a like character committed by the opposite party against those of his own. But all who do not allow a set-off to be pleaded in matters of right and wrong will, I think, if they look for themselves, find it necessary to disavow the cause and the conduct, and to regret the consequences.

LXII. *The Law of the Nutrition of Animals pointed out by Dr. R. D. Thomson, illustrated by F. KNAPP, Ph.D., Professor of Technology and Chemistry in the University of Giessen*.*

ON the farm of Boussingault at Bechelbronn, in order to ascertain the quantity of milk produced, seven cows were subjected to an accurate series of experiments extending over a whole year. They received daily 30 pounds of hay, or of those roots similar in composition, and yielded together

* Translated from Knapp's *Lehrbuch der Chemischen Technologie*, band ii. by Mr. John Brown.

An English translation of the first volume of this work by Messrs. Ronalds and Richardson has just appeared.

8788 maass (3837 quarts). The time during which they supplied milk was $302\frac{1}{2}$ days. This gives as a mean 4.1 maass (1.8 qt.) daily for each cow. But the quantity of milk varies very much; for in the months of July and August they yielded above 6 maass (2.64 qts.), while in February and March they gave only about $2\frac{1}{2}$ maass (1.1 qt.). From observations of a similar nature, made however upon only one cow, the average daily quantity of milk yielded was 3.7 maass (1.63 qt.). If we take $2\frac{1}{2}$ maass (1.097 qt.) as the lowest quantity, and 7 maass (3.073 qts.) as the highest, we get daily, for one cow, from 10.3 lbs. to 29 lbs. of milk, which contain—

4.69 oz. troy to 13.04 oz. butter.

7.08 20.02 oz. sugar of milk and sol. salts.

7.88 22.18 oz. caseine and insol. salts.

Total 19.65 55.24 oz. solid matter.

In reference to the influence which the food has upon the quantity of milk, all farmers know that cows give most milk with green food and less with hay, &c. In other respects the influence of the food is not so great as might be expected.

Boussingault and Le Bel agree upon this point, at least so far as concerns the quantity of milk*. Dr. R. D. Thomson, on the contrary, draws from similar and equally extensive experiments the conclusion, that the quantity of milk and butter increases in proportion to the quantity of nitrogen (contained in the plastic matter) of the food. He has drawn this conclusion from experiments upon two cows during periods of five days. His results are shown in the following table, in which grass is the only exception†.

Kind of food.	Pounds of milk.	Pounds of butter.	Nitrogen in the food in 5 days, in lbs.
Grass	114	3.50	2.32
Barley and hay	107	3.43	3.89
Malt and hay	102	3.20	3.34
Barley, molasses and hay ...	107‡	3.44	3.82
Barley, linseed and hay.....	108	3.48	4.14
Beans and hay	108	3.72	5.27

* Boussingault has recently found that hay is equally efficacious with grass in producing milk and muscle; a result which is certainly not applicable to hay made in usual seasons in this country.—Tr.

† Dr. Thomson attributes the superiority of grass to the proper balance of the proximate principles, which in hay and grain is much altered by the drying process.—Tr.

‡ In Dr. Knapp's work the number taken from the original is 106. The present number has been recalculated from the original data.—Tr.

Another table gives the average quantity of solid constituents of the milk for periods of five days.

Kind of food.	Grass.	Barley entire.	Malt entire.	Barley crushed.	Malt crushed.	Barley and Molasses.	Barley and Linseed.	Beans.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Milk.....	29.64	25.57	24.82	28.12	26.61	26.96*	27.48	27.0
Butter	5.96	5.56	6.56	6.87	6.43	7.00	7.00	7.5

The milk consists of—water, 87.19; butter, 3.70; sugar, 4.35; caseine, 4.16; sol. salts, 0.15; insol. salts, 0.44. The constituents of the butter are oil, 86.3; caseine, 0.9; water, 12.8.

The fact that not merely the quantity of milk but also that of the butter increases with the amount of nitrogenous matter in the food (that is, with the proportion of plastic nourishment), is worthy of notice; for from the absence of nitrogen in the butter, we should be apt to expect the contrary. Playfair, in his experiments, has certainly inferred this; for according to him, those substances which do not contain nitrogen (potatoes, &c.), yield milk rich in butter, and rest (stall-feeding) acts in the same way; while if the animal be allowed to feed on poor pasture, where it must move about a good deal, it yields milk rich in caseine. But his experiments are continued for such short periods, that important conclusions cannot be deduced from them. From Dr. Thomson's observations, we find that if a cow always receives the same kind of food, the quantity of milk gradually decreases; but if its diet be changed, it rapidly increases. A frequent change of diet is therefore advantageous. He has also established the rule, that the quantity of milk obtained from a cow is greater in the morning than in the evening.

When fed on barley and hay, they yielded—

	Aug. 1.	Aug. 2.	Aug. 3.	Aug. 4.
Morning .	11 $\frac{1}{2}$ lbs.	11 $\frac{1}{8}$ lbs.	10 $\frac{10}{16}$ lbs.	10 $\frac{14}{16}$ lbs.
Evening .	10 $\frac{1}{3}$	9 $\frac{11}{16}$	9 $\frac{11}{16}$	9 $\frac{11}{16}$

[The following observations of Dr. Knapp are founded on a table given by Dr. Thomson, deduced from his own experiments, in which the relation between the nutritive and calorifiant matter is stated for different kinds of food.

* This number is 25.69 in the original German, but has been recalculated from the English data.—Ta.

				Relation of nutritive to calorifiant matter.
Cow's milk—food for a growing animal				1 to 2
Human milk	...	...	...	1 ... 6
Beans	...	...	...	1 ... 2½
Oatmeal	...	...	...	1 ... 5
Semolina	}	...	...	1 ... 7
Barley				
English wheat flour—food for an animal at rest.				} 1 ... 8
Potatoes	...	...	...
Rice	...	...	...	1 ... 10
Turnips	...	...	...	1 ... 11
Arrow-root	}	...	...	1 ... 26
Tapioca				
Sago				
Starch	...	...	...	1 ... 40

(Thomson on the Food of Animals, p. 167.)

From this table it appears, that an animal taking exercise should be supplied with food formed upon the same principles as the first-mentioned six; and that in proportion to the exertion, the closer should be the relation between the ingredients.—Tr.]

In order to judge of the values of different kinds of food for practical purposes, it must first be ascertained in what relation the blood-forming or nutritive constituents stand to the calorifiant. The kind of food must also vary with age, kind of employment, way of living, climate, &c. With the highest probability we may predicate, that a man in an employment demanding great mental activity will require, in addition to a greater proportional amount of bodily rest, that the calorifiant and blood-forming constituents should be in a different proportion in the food, to that of the man whose employment requires great bodily activity.

Thomson has traced out a very simple and ingenious method of supplying this defect in our knowledge. He ascertains the weight and composition of the food given in a certain time, as also that of the excrement thrown out. From both factors he is enabled to calculate the quantity of food assimilated, as also the relation of the calorifiant to the blood-forming constituents. He found that a cow, stall-fed, assimilated daily 15·28 lbs. of rye-grass, which contained 1·56 lbs. of blood-forming and 13·00 lbs. of calorifiant matter. They thus stand in the relation of 1 to 8½, a proportion which, it is highly probable, is much more nearly related in man, as the relation in the various kinds of farinaceous food is about 1 to 5 or 1 to 6. We know

with certainty that in the infant the relation, as in milk, must be 1 to $2\frac{1}{2}$.

A company of soldiers were fed on flesh, bread, vegetables, legumes, beer, brandy, fat, &c. ; and from the experiments made on these by Liebig, the relation of the blood-forming to the calorifiant matter in the food may be accurately determined. By ascertaining the amount of food taken and the excrement thrown out, the quantity of food assimilated may be determined, as also the above-mentioned relation. In this manner the following results were obtained:—

		Water.	Solid matter.	Relation of the blood-forming to the calorifiant matter with solids.
Pounds of food consumed	4001	1655	2346	298 : 1357
Pounds of excrement . .	294	$220\frac{1}{2}$	$73\frac{1}{2}$	13 : 51

Relation of the blood-forming to the calorifiant matter in the food assimilated } $285:1306=1:4.7$.

As this number 4.7 is calculated from experiments made on persons who undergo considerable bodily exercise, it will increase* in those whose employment is sedentary. Although these numbers are not absolutely correct, some important conclusions may be drawn from them.

It is evident that the relation 1 to 4.7 is almost exactly that which exists naturally in the various kinds of grain. Those barbarous nations which live entirely on flesh, receive a large excess of blood-forming matter, which may be counterbalanced either by the addition of calorifiant matter, or by increased bodily exercise. On the contrary, the poorer classes amongst us are obliged to live on the cheapest food they can obtain, such as potatoes, &c.†, which are one half poorer in blood-forming or nutritive matter than the different kinds of grain. In the first case nature has only to get rid of an excess; but in the latter she has to supply a deficiency, which must be done by bread, milk, &c. It must be evident to every one that this way of living is unnatural in the extreme. A person living

* The word in the original is "vermindern;" but in the present case it is obvious that the author means the reverse of diminution.

† "The previous views," says Dr. Thomson (on Food, p. 173), "sufficiently explain the experiments which have been made upon cows, in which the result was unfavourable when they were fed on potatoes and beetroot in considerable quantities, as both of these substances contain an excess of calorifiant matter. It is well-known to feeders of cattle, that an animal fed on large quantities of potatoes is liable to such complaints as affections of the skin, and also to loss of weight. These consequently, it may be readily inferred, arise from the want of the proper balance between the elements of the food."—TA.

entirely on potatoes may be said to be on the brink of a precipice without a single inch of ground before him, where the only safety lies in retreat. Its disadvantages may be shown in three different ways:—1st. It leads to imperfect bodily strength and unsoundness of health. 2nd. To increased mortality and shortness of life. 3rd. To loss of energy and to a kind of stupidity, and want of interest in everything but what concerns the merest animal interests. A country in this state is always ripe for rebellion, and ready to join in every insurrection.

From the above remarks, it would appear that the manufacture of brandy from potatoes is a separation of the excess of calorifiant matter, whilst the residue contains all the blood-forming constituents. It is mixed with the gluten of the malt, and thus forms a half-soluble food. In order however that it may suit the nature of ruminating animals, straw or some such food should be added to it. As potatoes contain about one part of albumen for ten of starch, the half of the starch may be converted into spirit, while the remainder will consist of a mixture having the nutritive and calorifiant constituents in the same proportion as in grain (1 : 5).

LXIII. *Objections to the Theories severally of Franklin, Dufay and Ampère, with an Attempt to explain Electrical Phenomena by Statical or Undulatory Polarization**. By ROBERT HARE, M.D., *Emeritus Professor of Chemistry in the University of Pennsylvania*†.

1. **I**T appears, from the experiments of Wheatstone, that the discharge of a Leyden jar, by means of a copper wire, takes place within a time so small, that were the transfer of a

* Agreeably to Faraday's researches and general experience, we have reason to believe that all particles of matter are endowed with one or the other of two species of polarity. This word polarity conveys the idea that two terminations in each particle are respectively endowed with forces which are analogous, but contrary in their nature; so that of any two homogeneous particles, the similar poles repel each other, while the dissimilar attract; likewise when freely suspended they take a certain position relatively to each other, and on due proximity, the opposite polar forces, counteracting each other, appear to be extinct. When deranged from this natural state of reciprocal neutralization, their liberated poles react with the particles of adjacent bodies, or those in the surrounding medium. Under these circumstances, any body which may be constituted of the particles thus reacting, is said to be polarized, or in a state of polarization.

Statical implies stationary; undulatory, wave-like.

† Read before the Academy of Natural Sciences, and communicated, with corrections and additions, by the Author.