of cutting down upon and dividing the gland, may, if the patient be younger than usual, and the disease without complication, be just allowable; though, in a disease such as the prostatic, palliation is, I think, better than the adoption of curative measures that involve the least risk. To subject, however, an aged individual to this, an operation fraught with nearly as great danger as that of lithotomy, is, in my mind, an act little short of homicide.

ART. VI.—*On the Coagulability of Human Milk.* By WILLIAM D. MOORE, A. B., M. B.

HAVING some time ago commenced a series of experiments on human milk, principally with a view to the observation of such changes as might be produced in its physical and chemical properties by the supervention or existence of disease in the nurse, and to the establishment of rules by which such morbid changes might be recognised, I found myself in a great measure anticipated by the appearance of a paper by Dr. Peddie, of Edinburgh, “on the Mammary Secretion and its Pathological Changes,” &c., published in the *Monthly Journal and Retrospect of the Medical Sciences*, for August, 1848, and containing much valuable information on the subject.

I need not here dwell upon the great importance of being able to decide whether the secretion intended by nature for the nourishment of the infant be in a healthy state or not. This is sufficiently obvious. But I may remark that any process for determining this question by chemical means should, in order to be practically useful, be simple, easy of execution, and should require but little time for its accomplishment. I did not, therefore, propose to institute in every case an elaborate analysis, but simply to note the specific gravity, the reaction, the appearance and taste of each specimen, the amount of cream thrown up in a given time, the appearance of the milk under

the microscope, and the effect produced upon it by the application of heat and acids.

Being able, however, to refer the reader to Dr. Peddie's paper for an account of the changes produced in it by disease, I shall proceed to consider some of the leading characteristics of healthy human milk, especially those in which it differs from the mammary secretion of the animals whose milk forms in these countries, either ordinarily or occasionally, part of the food of man; and as one of the most striking of these differences is its behaviour in relation to heat and acids, the disputed question of its coagulability will form the principal subject of this paper. In conclusion, I shall endeavour briefly to draw such practical inferences as the facts observed may warrant.

That a point which might, at first sight, be supposed to admit of an easy demonstration, should be a matter of difference of opinion between eminent chemists, may well excite surprise; but that the fact is so will be at once seen by placing in juxtaposition the following statements made by two who deservedly rank among the first authorities on animal chemistry, I allude to the late Professor Berzelius and the late Dr. J. Franz Simon. "The most essential character," says the former, "of woman's milk consists in this, that the caseous matter which is found dissolved in it forms soluble combinations with acids, in consequence of which we cannot coagulate it by means of these latter"(a). The latter, on the contrary, speaking of the "ordinary milk of the human female," asserts that "every thing that precipitates caseum coagulates milk"(b). Dr. Peddie, in the paper I have already alluded to, states that human milk "will precipitate curd from the serum or whey, if mixed with the mineral, acetic, or lactic acids"(c).

(a) *Traité de Chimie*, par J. J. Berzelius, traduit par Me. Esslinger; tom. vii. Paris, 1833.

(b) *Animal Chemistry with reference to the Physiology and Pathology of Man*; Sydenham Society Translation, vol. ii. p. 51. London, 1846.

(c) *Monthly Journal, &c.*, August, 1848, p. 66.

Professor Young concluded, from numerous experiments, that human milk is not coagulated by rennet; and that acids, whether mineral or vegetable, mixed with it in large quantity, do not produce any separation of curd from whey, whether the milk be tepid or raised to the boiling point(a).

Berzelius, on the contrary, states that, although the milk of woman cannot be coagulated by acids, rennet coagulates it regularly. One part of rennet to 500 of milk, he says, coagulates the latter at a temperature between 40° and 50° (104° and 122° of Fahrenheit), but slowly; the caseous matter, he adds, does not unite into a mass, as in cow's milk, but takes the form of isolated flakes(b).

The experiments of Professor Young were confirmed by Dr. Ferris, whose Dissertation on Milk gained the Harveian prize medal at Edinburgh in the year 1782(c).

In a pamphlet entitled "the Analysis of Milk, and the different Species thereof," published in 1762, Dr. John Rutty, of Dublin, it is stated that "woman's milk, coagulated by the same quantity of rennet as cow's milk, gave of curd very little, even not one-sixth of what cow's milk did"(d).

The late Dr. Joseph Clarke, who so long held an eminent rank in this city, and whose extensive experience demands attention for any opinion advanced by him, conceived that human milk, in a healthy state, contains little or no curd; and that viscid cream rejected by the stomachs of infants has given rise to the opinion of curd in the milk vomited by them(e).

Having stated the following as a generally received opinion among medical writers, viz., "that human milk is coagulated in the stomach of infants, and that it is coagulable by acids,

(a) See Dr. Clarke's paper in the Transactions of the Royal Irish Academy for 1788, p. 174.

(b) *Loc. cit.*

(c) Dr. Clarke's paper.

(d) A memoir of Dr. Rutty is given in the third volume of the present series of this Journal, p. 555.

(e) Transactions of the Royal Irish Academy, 1788, pp. 177, 178.

ardent spirits, and other known coagula," Dr. Clarke proceeds to inform us that he made a great number of experiments "in endeavouring to detect the curd of human milk, but without success." For this purpose he made use of all the different kinds of acids, ardent spirits, infusions of infant's stomachs, &c., in various proportions and degrees of temperature, and, except in one or two instances, never could perceive anything like curd. The following experiment I shall give in Dr. Clarke's words, as I shall have to allude to it hereafter:

"I took out the stomach of a fœtus deprived of life in the birth by lessening the bulk of its head. The gastric fluids in such a stomach could neither be altered by disease nor the admixture of food. I infused it in a small quantity of hot water, so as to make what might be considered a strong infusion. To equal quantities of cow's and human milk I added a tea-spoonful of the above infusion; in a short time the cow's milk was firmly coagulated, the human not in the least changed. At the end of the first hour I added a second tea-spoonful of rennet to the human milk, and soon after a third, without producing the smallest perceptible tendency to coagulation."

Johnson^(a) states that "all the methods of coagulation used in cow's milk succeeded in coagulating human milk, except vinegar, and the mineral acids very much diluted with water." In the coagulation of cow's milk he had employed the vitriolic, nitrous, muriatic, and phosphoric acids, vinegar, and the infusion of the dried stomach of a calf.

"It appears," he adds, "that the longer a milk is drawn, from the time of lying-in, the more caseous matter it contains, and then it is coagulated by acids; but the coagulation is always viscous, and never acquires that gelatinous consistence observed in the caseous matter of the cow." He subsequently quotes

(a) History of the Progress and present State of Animal Chemistry, by W. B. Johnson, M. B. London, 1803, vol. i. p. 156.

the experiments of Stipriaan, to the effect that "human milk was not coagulated by any of the acids, whether heat was used or not, nor by the rennet of the lamb or calf," but that it "was coagulated either by letting it become sour and boiling it, or using old sour milk; this cheese," he adds, "was much finer, more tender, and softer than that of other milk; it, however, cannot be collected in a lump."

"It is, perhaps," continues Mr. Johnson, "owing to the great difficulty, if not impossibility, of procuring this milk in a nearly similar state, which some authors have attributed to the irregularity of the human mode of living, that the experiments of chemists differ so much respecting its coagulation, as there is no other milk which is so readily affected by the difference of nourishment." He concludes by giving a view of Dr. Clarke's experiments and opinions on the subject.

Another suggestion of his is, that "the property of human milk, in not being always subject to coagulation by acids, appears to depend on the small quantity of caseous matter it contains, and its extension in this fluid; and this explanation," he says, "is confirmed by Scheele's experiments, which prove that cow's milk, diluted with six parts of water, loses the property of coagulation"(a).

Fourcroy asserts that all the processes which coagulate the milk of the cow produce the same effect upon that of a woman, but that the cheese is, in general, softish, unctuous, and does not acquire the same concrete state(b).

Among the milks of fifteen women which Meggenhofen examined, three only were coagulable by hydrochloric and acetic acids(c).

(a) I found no difficulty in coagulating cow's milk, diluted with six parts of water, by boiling it with a very minute quantity of nitric, hydrochloric, or acetic acid.

(b) A General System of Chemical Knowledge, &c., translated from the French of A. F. Fourcroy, by William Nicholson. London, 1804, vol. ix. p. 536.

(c) Berzelius, *loc. cit.*

Dr. Carpenter observes that "the casein of human milk is much less precipitable by acids than that of the cow, very commonly resisting the action of the mineral acids, and even that of the acetic, but being always coagulated by rennet, though the curd is long in collecting"(a).

With a view to ascertain which of the foregoing apparently contradictory classes of statements is correct, or, if possible, to reconcile them, I performed a great number of experiments, and have finally come to the conclusion, that the casein of human milk forms, with most acids, two sets of compounds, the one, when a certain quantity of acid is used, soluble in water, the other, when a different quantity of acid is used, insoluble in water(b), and that accordingly as each experimenter formed the soluble or the insoluble compound, he reported the milk on which he operated to be incapable or capable of coagulation with acids; and as the amount of acid necessary to coagulate the casein, will vary with the quantity of the latter which may happen to be present in a given specimen, it is possible that opposite results may have been arrived at by the same experimenter using the same quantity of acid with different samples of milk, giving rise to such statements as that I have just quoted from Dr. Carpenter, that "the casein of human milk very commonly" (but not always) "resists the action of acids."

(a) Principles of Human Physiology, by William B. Carpenter, M. D., F. R. S. Third edition. London, 1846, p. 667.

(b) This might perhaps be deduced from two observations made by Simon in two different works; one, that which I have already quoted from his Animal Chemistry, that "everything which coagulates casein coagulates (human) milk." The other is given by Berzelius in the ninth volume of his *Lehrbuch der Chemie* (1840), p. 699, and is probably taken from Simon's work, entitled "*Die Frauenmilch nach ihrem chemischen und Physiologischen Verhalten*," which I have been unable to procure in Dublin. It is to the effect, that by far the greater number of the combinations of human casein with acids are soluble in water. These two apparently opposite statements are only reconcilable on the supposition of the existence of the two classes of compounds.

I shall now proceed to describe some of the experiments which have led me to this conclusion. In each experiment I have, in consequence of the difficulty of obtaining a large supply of human milk, operated on two fluid drachms; and that the comparative experiments might be similar in every respect, I have used a like quantity of those milks which were more easily procurable.

EXPERIMENT I.—A portion of cow's milk, measuring two fluid drachms, boiled with a single drop of nitric acid, s. g. 1.417, was immediately resolved into a firm curd and whey; the same result took place when two fluid ounces of milk were used with a single drop of the acid.

EXPERIMENT II.—Two drachms of human milk, boiled with one drop of the same acid, remained uncoagulated. Filtered, a slightly opaline solution passed through, which, when examined under the microscope, was found to be quite free from milk globules. A light, creamy deposit remained on the filter, which, when mixed with a drop of water and examined under the microscope, was found to consist chiefly of unaltered milk globules; the presence of casein, in combination with acid, was demonstrated in the filtered liquid, by the addition to a portion of it, of a few drops of a solution of ferrocyanide of potassium, which immediately produced a copious precipitation(a).

The filtered solution was treated with ether. On allowing the latter to evaporate spontaneously, a white residue was obtained, which afforded a clear solution with water of caustic potash.

EXPERIMENT III.—Two drachms of human milk were boiled with five drops of the same acid. Coagulation took place, but was not very manifest until after the lapse of some hours. It was then filtered. A copious caseous precipitate remained on

(a) "The soluble combinations of caseous matter, with acids, are precipitated by ferrocyanide of potassium."—Berzelius, *op. cit.* vol. vii. p. 600.

the filter, which, when examined under the microscope, was found to contain numerous unaltered milk globules; the filtered liquor was quite clear, and on the addition of ferrocyanide of potassium exhibited no trace of casein. It was evident that in this case the acid coagulated the entire of the casein present in the milk.

EXPERIMENT IV.—The last experiment was repeated with ten drops of nitric acid, with the same results, except that the coagulation took place immediately.

I may here remark that the quantity of acid necessary to produce a coagulation sufficiently rapid to be immediately visible, will vary with the amount of casein present in the particular specimen of milk. I have sometimes observed immediate coagulation on using five drops, and sometimes ten have scarcely produced this result; but in no specimen that I have examined have I failed to produce it by adding a sufficiency of acid.

EXPERIMENT V.—Two drachms of human milk were boiled with two drops of dilute hydrochloric acid; no coagulation was produced; the filtered solution was almost perfectly clear; and ferrocyanide of potassium produced a copious precipitate. In this case it is evident that, as in Experiment II, a soluble combination of casein with acid had been formed, and passed through the filter. One drop fully coagulated two drachms of cow's milk.

EXPERIMENTS VI., VII.—Were repetitions of the fifth experiment, substituting twenty drops and one drachm, respectively, of dilute muriatic acid, for the quantity used in No. v.; coagulation was produced in both cases, slowly in No. vi., immediately in No. vii. The filtered solution was clear; a caseous deposit remained on the filter, and the filtered liquid gave no precipitate with ferrocyanide of potassium.

It will be seen that in the foregoing experiments with nitric and hydrochloric acids, the compound of casein and acid was soluble when a small quantity, but insoluble when a large quantity of the latter was employed. With acetic acid, how-

ever, the very reverse is the case, as will be seen by the following experiments.

EXPERIMENT VIII.—Two drachms of human milk were boiled with one drop of strong acetic acid; a perfect coagulation took place; the filtered liquid gave no precipitate with ferrocyanide of potassium; the coagulum on the filter contained unaltered milk globules.

EXPERIMENT IX.—A similar quantity of the same milk was boiled with ten drops of strong acetic acid; a coagulation took place, but to a much less amount than in Ex. VIII.; the filtered fluid gave an abundant precipitate with ferrocyanide of potassium.

EXPERIMENT X.—The foregoing experiment was repeated with half a fluid drachm of strong acetic acid; no coagulation took place; the filtered solution gave a copious precipitate with ferrocyanide of potassium.

In the foregoing experiments the acid solutions of casein passed through the filter (consisting of the ordinary coarse filtering paper) slightly opaline; they were quite free from milk-globules: the filtered fluids which contained no casein were transparent as water. When cow's milk, human milk, and boiled human milk, were passed through the same paper, the filtered fluid was little altered, contained numerous milk-globules, and, although some cream was retained on the filter, threw up a layer of that substance.

When cow's milk and goat's milk are mixed, without the aid of heat, with a very minute quantity of acetic acid, or with almost any proportion of nitric or hydrochloric acid, a strong coagulation immediately takes place. On the other hand, when ass's or human milk is mixed, without heat, with a very minute portion of acetic acid, or with a large portion of nitric or hydrochloric acid, no change is at first perceived. After some time a separation of soft flaky coagula takes place in the ass's milk, and a similar change occurs more slowly and less visibly in the human milk. If the four milks be now

filtered, and the filtered fluids be tested with ferrocyanide of potassium, no precipitation will take place, except in the specimens of human milk and ass's milk, which were treated with acetic acid, showing that in the other ten cases the separation of casein by means of acid has been complete.

The casein of human milk, when coagulated by an acid, does not form a dense, firm coagulum, like that of the cow or goat, but is soft and flaky, and generally floats near the surface of the fluid; this latter circumstance, however, is owing rather to the tenuity of the milk than to any peculiarity in the coagula; for, when cow's milk is much diluted with water, and its casein coagulated by heating it with an acid, the coagulum, (although the density of the milk is diminished by dilution), for the most part, floats near the surface, proving that in the other case its suspension in the serum is owing to the viscosity of the latter.

If human milk be left to itself for several days, a certain amount of coagulation takes place; some flaky coagula mix with the cream, and float near the surface, while others sink to the bottom.

Berzelius states that caseous matter gives, with a small quantity of acid, a combination soluble in water; and that with a larger quantity of acid it affords a combination but little soluble in water(*a*). This statement appears by the foregoing experiments to be quite correct in reference to the action of nitric and hydrochloric acids on human casein; yet the same authority states, as I have already mentioned, that the casein of human milk forms soluble compounds with acids, in consequence of which it cannot be coagulated by these reagents(*b*). By acting on cow's milk diluted with water, with a very small quantity of hydrochloric acid, and filtering, I easily obtained a solution in which the presence of casein was demonstrable by adding ferrocyanide of potassium. I did not succeed in

(*a*) *Traité de Chimie*, vol. vii. p. 600.

(*b*) Page 625.

forming a soluble compound of the casein of cow's milk with nitric acid. With acetic acid, added in small proportions, the casein of both cow's and human milk forms an insoluble compound which is, however, dissolved by an excess of the reagent.

It would then appear from the above experiments that the great difference between human and cow's milk, in reference to their coagulability, consists in this: that the range of soluble compounds formed by the casein of the former with acids is much more extensive than that of those formed by the casein of the latter.

It is well known that the coagulation of its casein is the first change which milk undergoes in the process of digestion(*a*); it is, therefore, not surprising that an acid which, when present even in very minute proportion, possesses this power, should be found as an element of the gastric juice; accordingly, the presence of acetic, as well as of hydrochloric acid, has been demonstrated in this fluid.

Dr. Clarke, as we have already seen, failed to coagulate human milk with the stomach of a child which was deprived of life *during* birth. With the stomachs of two children which perished in a similar manner, one from prolapse of the funis, the other by craniotomy, I could obtain no satisfactory coagulation; with the stomach of a child, however, which had lived some time, a decided coagulation was effected. No firm coagulum was formed, nor was the effect immediately perceptible, but after standing for a few hours the milk was seen to be full of minute flaky coagula, resembling minute acicular crystals(*b*);

(*a*) See West's Lectures on the Diseases of Infancy, &c., London, 1848, p. 338.

(*b*) In this case, and in that of the fœtus which perished by prolapse of the funis, I did not use the ferrocyanide of potassium test. Of the stomach of the fœtus, which perished by craniotomy, an infusion was made (No. I.). An infusion was at the same time made of the stomach of a child which had lived for some time (No. II.). Some of the infusion (No. I.) was added to

this effect was more decidedly produced on human than on cow's milk. Simon states(*a*), that "the mucous membrane of an infant a few days old, that has recently died, seems to coagulate woman's milk more perfectly than the mucous membrane of the stomach of the calf." Can it be that the stomach of the newly-born infant does not acquire a coagulating power until it has been subjected for some time to the stimulus of food? The milk secreted during the first hours of lactation is, as we shall presently see, coagulable by heat alone, which might be a provision to meet the weak coagulating power of the digestive organs.

In the experiments which I made with the stomachs of infants, they were placed each in a porcelain capsule, covered with distilled water, and placed in a water-bath, the heat of which was not allowed to rise above 120°. After the infusion had stood sufficiently long, a portion of it was added to the milk to be operated on, and the mixture in like manner was prevented acquiring a higher temperature than 120°. This precaution was taken to prevent the coagulation of the infusion, which was always highly albuminous.

human milk, the mixture placed in a water bath, and allowed to remain for a time at a temperature of 120° F.; it was then filtered; some coagulum remained on the filter; the filtered solution was slightly acidulated with acetic acid, and ferrocyanide of potassium was added; a precipitate was immediately produced. This experiment was repeated with the infusion (No. II.); the addition of the ferrocyanide produced no effect. It is evident that the coagulating power of No. II. was much stronger than that of No. I. Each was then tried with ass's milk, no coagulum remained on the filter, and the filtered solutions gave copious precipitates with the ferrocyanide. With cow's milk No. I. left a slight coagulum on the filter; the milk passed through but little altered, and, being acidulated as above, gave a copious precipitate with the ferrocyanide. The liquid filtered from the cow's milk treated with infusion No. II. was much clearer than the last, and gave a precipitate not nearly so copious. The only case, then, in which the coagulation seems to have been perfect, was that in which human milk was treated with infusion No. II.

(*a*) Animal Chemistry, vol. ii. p. 51.

Coagulability by Rennet.—Berzelius(a) observes, that the casein of woman's milk is with difficulty coagulated by the stomach of a calf, in consequence of the free alkali it contains; but that when the latter is saturated by an acid it coagulates as readily as that of cow's milk. I mixed a portion of human milk with rennet, and applied heat; no coagulation took place: on filtering the mixture, and adding a solution of ferrocyanide of potassium, a copious precipitate was obtained. Another portion of the same milk was treated in a similar manner, having been previously rendered slightly acid; it was coagulated, and by filtration afforded a clear liquor, which was not affected by the ferrocyanide of potassium. The possibility of one experimenter having operated on a specimen of milk which had become spontaneously acid, while another used one which retained its natural alkalinity, will hence account for the discordant opinions given on this subject.

Human milk is whitish, with a slight tinge of blue, considerably thinner than cow's milk. It is always alkaline; when boiled it becomes, like every other kind of milk, covered with a film of coagulated casein. (Simon). According to Scherer, if the serum of blood be diluted with water, and gently heated, or, still better, if it be mixed with alkali, before being heated, a pellicle similar to that on milk is formed, and the rest of the fluid is not coagulated. In both cases the formation of this pellicle is owing to the oxygen of the air, for it does not take place in an atmosphere of carbonic acid(b).

On examination with the microscope human milk is seen to consist of numerous globules of various sizes, floating in a colourless fluid. This fluid holds in solution casein, sugar of milk, and various salts. With regard to the nature of the globules different opinions have been entertained. Some, as M. Raspail(c), have

(a) *Lehrbuch der Chemie*, 9ter Band, Dresden und Leipzig, 1840, p. 699.

(b) Wagner's *Handwörterbuch der Physiologie*, u. s. w., Braunschweig, 1845, vol. ii. p. 453.

(c) *Nouveau Systeme de Chimie Organique*, Paris, 1838, t. iii. p. 136.

supposed that some of them are oleaginous, others albuminous. Donné, on the other hand, argues that since the globules entirely disappear when agitated with ether, they must all belong to the fatty element of the milk(a). Simon considered them to be fat vesicles, having an envelope of coagulated casein(b).

Human milk rapidly throws up an abundant cream; this is sometimes accidentally diminished. In a patient of Dr. M'Clintock's, whose milk I examined on the second day of menstruation, and in the seventh month of lactation, and in whom the menses had regularly returned since the fourth month of nursing, I found the cream very deficient. This was the only peculiarity I could discover in the milk. Some days after the catamenial flow had ceased I examined the milk again, and found that it threw up twice as much cream as it had done during the continuance of the menstrual period. M. Raciborski, from an examination of the milks of seven nurses, taken during menstruation, concludes that the only peculiarity which milk drawn at such a time seems to present is, that it is less rich in cream than during the intervals between the flux. He also was of opinion that the supposed inconvenience of the milk during menstruation has been much exaggerated, and that a nurse ought never in any case to be rejected simply because she continues to menstruate(c).

This opinion, is, however, certainly not correct, as children always suffer an amount of inconvenience when the nurse menstruates, which, repeated at the end of every month, would produce a decidedly injurious effect upon them. In these cases all children suffer more or less from sickness of stomach, disordered state of the bowels, and in some cases even convulsions have occurred, though it may be admitted that when the menstrual period is over, the milk no longer appears to disagree with

(a) *Cours de Microscopie*, Paris, 1844, p. 356.

(b) *Animal Chemistry*, vol. ii. p. 42.

(c) Quoted in *Edinburgh Medical and Surgical Journal*, vol. lxi. p. 228, from *Journal de Pharmacie*, Aug. 1843.

the child. It is also found to produce an injurious effect upon the mother if she continues to nurse after the catamenia return, and if her general health is impaired it must obviously react upon the child. For these as well as other reasons, most practitioners in midwifery agree in considering that a nurse who menstruates ought to be rejected. And it is for this reason, and not for want of experience, that an objection is made to women with their first children, or who nurse for the first time, as with them menstruation generally returns after a few months.

The specific gravity of human milk is very variously stated in different works: Berzelius says it ranges from 1·020 to 1·025, and sometimes a little higher(*a*); Raspail quotes it at the same, stating, however, that it will vary with climate and other circumstances(*b*); Simon states it at from 1·030 to 1·034, and gives as the average 1·032; Brisson makes it so low as 1·0203(*c*). Of twenty specimens of healthy milk, of which I took the specific gravity, the highest was 1·033, the lowest 1·025, the average 1·0299. The specific gravity will, of course, vary with the amount of secretion and the period of lactation.

The *colostrum*, or the first milk secreted after the commencement of lactation, differs remarkably from ordinary milk; it is thick, of a yellow, yellowish, or dirty whitish yellow colour. On standing, a viscid deposit forms at the bottom, while a thick, yellow cream mounts to the surface of the fluid; it is alkaline; exhibits under the microscope some true milk-globules, generally irregular and badly formed, some of them resembling large drops of oil; it also contains a number of very small globules, presenting throughout the fluid a pulverulent appearance; many of the globules exist in agglomerated masses: in addition we perceive the granular bodies described by Donné(*d*); this author states, that on dissolving the fatty parts of

(*a*) *Lehrbuch der Chemie*, 9ter Band, p. 697.

(*b*) *Op. cit.* t. iii. p. 157.

(*c*) Rees' Cyclopæd. a, art. Milk.

(*d*) *Op. cit.* p. 400; see also Dr. Peddie's paper.

the colostrum by ether, mucous globules(*a*) are seen to exist in it. Accordingly we find that caustic potash converts colostrum into a gelatinous mass.

The colostrum differs remarkably from ordinary milk in being coagulable by heat; it will often become, on the application of heat, solid like white of egg; it also affords an immediate coagulation when mixed with nitric or hydrochloric acid without heat. On adding acetic acid to a portion of colostrum it appeared at first to be very slightly coagulated, but on examining it at the end of some hours it was found to have solidified. This state of extreme coagulability lasts for a very short time; I have found it to have disappeared before the end of the first day of lactation.

Colostrum is much richer in solid constituents than ordinary milk, especially in butter and sugar; the casein and salts are also increased. Simon attributes the well-known aperient property of the colostrum to the increased quantity of salts and sugar of milk(*b*).

It was seldom I could obtain colostrum in sufficient quantity to take its specific gravity; of eight specimens, the highest was 1.034, the lowest 1.028, the average 1.0316.

To Dr. Sibthorpe, assistant physician at the Dublin Lying-in Hospital, I am indebted for all the specimens of colostrum, and for many of those of ordinary milk, which I have examined. Without the zealous co-operation which he so kindly afforded me, I should have been unable to carry on the present investigation.

Although I stated that I should not in this paper enter into a consideration of the changes produced in the milk by disease or other circumstances, the following case so nearly simulates one with the colostric secretion that I shall briefly mention it here; it was furnished to me by my friend Dr. Sibthorpe. In

(*a*) *Cours de Microscopie*, p. 401; Donnè supposed the granular bodies to be composed of fatty matter and of this peculiar mucus.

(*b*) *Animal Chemistry*, vol. ii. p. 50.

two respects only does it appear to differ from colostrum, viz., in its specific gravity and taste. It was the milk of a woman who had been nursing for the almost incredible period of two years and nine months. She was, as might be expected, dyspeptic, and was menstruating when the milk was taken. It was of a dirty white colour, alkaline, threw up a considerable cream; specific gravity 1.024; taste saltish; was converted into curds and whey by the application of heat; and exhibited under the microscope numerous colostric bodies, and agglomerated globules.

The milk of the cow and goat form dense coagula with acids, and throw up an abundant cream. That of the ass, on the contrary, has, like the milk of woman, a more extended range of soluble combinations with acids; and its coagulation, while it takes place much more easily than that of human milk, resembles it strongly in consistence, being soft and flaky; hence its adaptation to the infant and valetudinarian stomach. In tenuity, also, it bears a close resemblance to woman's milk, and, in consequence of this property, its coagulum, for the most part, floats near the surface(*a*).

In the proportion of saccharine matter also, which it contains, it approaches more nearly to woman's than do the other milks I have mentioned. In one important particular, how-

(*a*) Ass's milk contains much less casein than human milk, hence it ought, if the casein of both be of the same nature, to be coagulable by a less proportion of acid; that is, a given quantity ought to require less acid to form with its casein an insoluble compound; and such we find to be the case. The milks of the cow and goat, on the contrary, contain a considerably larger proportion of casein than woman's milk does; and, consequently, if the chemical relations of their casein were similar, they should require much more acid for their coagulation, but they coagulate with infinitely less. We have also seen that the effect of acids, when employed without heat, is different on these two classes, if I may so speak, of milks. For these reasons I am inclined to think that some difference might be found in the ultimate composition of the casein of human and ass's milk on the one hand, and of that of cow's and goat's milk on the other. I am not aware that any, except the casein obtained from cow's milk, has been subjected to analysis. The one

ever, it differs from human milk,—it is very deficient in cream. For this reason I should be inclined to recommend that, when ass's milk is administered as nourishment to infants, it should be mixed with a twentieth part of cow's cream. The necessity of an oily element in the food of man is well known, and this is certainly very deficient in ass's milk. By this addition the milk is rendered much more palatable.

The importance of administering oily matter in many diseases is now very generally recognised. Dr. Bennett believes “that the therapeutic action of cod-liver oil is essentially dependent on its fatty nature. To him it seems certain, that in tubercular diseases (and in chronic rheumatism) the albuminous compounds are in excess, and the oily compounds diminished in the economy. The direct addition of the latter, therefore, is the most rational method of supplying the wants of the system”(a). If these views be correct, the addition I ventured to suggest would, I should think, be found in many cases an improvement, especially as ass's milk is so often ordered in the class of diseases (tubercular) to which Dr. Bennett alludes.

It was probably the circumstance of its containing an

class of milk appears to afford a less azotized nutriment, but to be well adapted to weak digestive powers, while the other contains a much more solid aliment, requiring a comparatively strong digestion.

The following analyses are taken from Simon's *Animal Chemistry*:—

Constituents of Milk.	WOMAN'S MILK.	ASS.	COW.	GOAT.
	Simon.—Average of fourteen Analyses.	Peligot.—Mean of several Analyses.	Simon.	Clemm.
Water,	888.6	904.7	857.0	865.175
Butter,	25.3	12.9	40.0	42.507
Casein,	34.3	19.5	72.0	60.321
Sugar of milk and extractive matters,	48.2	62.9	28.0	44.065
Fixed salts, . .	2.3		6.2	

The butter in woman's milk in the above table is lower than that given in most other analyses. Simon gives 54.0 as the maximum.

(a) Braithwaite's *Retrospect*, vol. xvii. p. 365.

abundance of cream or fatty matter which induced Helvetius to recommend goat's milk in preference to ass's, and as "particularly proper to restore children in consumptions, as well as other extremely thin and emaciated bodies." This quotation of Helvetius I take from Dr. Rutty, who has appended the following explanation and qualification, viz.: "as being more nourishing and less stimulating, though how far the circumstance of its being harder of digestion may determine its usefulness in particular cases, must be left to observation"(a).

The objection thus raised by Dr. Rutty is met, I conceive, by the proposal to combine the nourishing oily portion of cow's milk (which, I believe, when properly diluted, is not the least digestible portion of the milk), with a milk which, from its easy digestibility, is admirably adapted to the invalid stomach.

Donnè recommends the use of cow's milk from which the fatty matter has been almost entirely separated by filtration, as a light aliment, easy of digestion, sufficiently nourishing, and having no laxative property. Such milk, he says, might be useful to children inclined to diarrhœa, to whom we might wish to give a light nourishment(b). The filtration is accomplished by means of filters of good paper, and the filtered liquid is not to be collected until it begins to pass perfectly transparent or very lightly opaline. There appears to me to be at least one capital objection to this proposal, which is, that by Donnè's own testimony, at least twelve hours are required for the filtration of half a pint. I need not say that the milk will not, by so long exposure to the air, become better adapted for administration in a case of diarrhœa, and it appears to me, that such a milk as M. Donnè would recommend is prepared by nature in the mammary gland of the ass.

Dr. Sibthorpe has taken the trouble to draw up for me

(a) The Analysis of Milk, appended to "The Argument of Sulphur or no Sulphur in Waters discussed." By John Rutty, M. D. Dublin, 1762; p. 15.

(b) *Cours de Microscopie*, p. 460.

some interesting tables relative to the periods at which lactation commences, which want of space obliges me reluctantly to omit. Of fourteen cases mentioned in these tables, one had a flow of milk three days before delivery, and two had milk at the time of delivery. In the remaining eleven cases lactation commenced as follows:—one at one hour, one at eight hours, two at eight hours and a half, one at ten, one at fourteen, one at eighteen and a half, one at twenty, one at thirty-three, one at thirty-seven, and another at thirty-eight hours after the birth of the child.

The analogy between the milk and the blood is most striking. The latter fluid, requiring so many and complicated processes for its elaboration, is presented to the newly born, whose powers would be quite unequal to the task, as it were, already prepared.

ART. VII.—*Observations on the late Epidemic Dysentery in Dublin.* By R. MAYNE, M.D., Physician to the South Dublin Union Workhouse, and Lecturer on Anatomy and Physiology at the Richmond Hospital School of Medicine.

A CONSIDERABLE period has now elapsed since the late epidemic of dysentery appeared in Dublin, and as my connexion with the South Dublin Union Workhouse afforded me vast opportunities for studying the disease, I have determined to submit the result of my observations to the profession.

From time to time, whatever cases possessed any interest were carefully noted, and the records thus obtained have furnished the materials for the following pages.

The better to show the progress of the epidemic, I have arranged in a tabular form the numbers of new cases in the workhouse each month, from April, 1846, to August, 1848, inclusive; those which arose within the workhouse are distinguished from those sick on admission; the monthly mortality is added; and a brief summary of the ages of all is appended.