[Extracted from the Transactions of the College of Physicians of Philadelphia.]

Cataract.—Dr. HAYS made some verbal remarks on this affection, of which the following is an abstract.

Dr. H. said he would offer for the consideration of the Fellows of the College some speculations which have lately been occupying his thoughts, and which, if well founded, would tend to invalidate a long accepted surgical precept, and also to elucidate the pathology of cataract.

There are few doctrines more firmly established, than that cataract is not amenable to medical treatment—that its progress can neither be arrested nor retarded by therapeutic measures—and that the only means of relief is a surgical operation. It certainly had been too often the speaker's painful task, when applied to by persons affected with incipient cataract and who anxiously inquired whether the progress of the disease could not be arrested, to be obliged to crush their hopes by the avowal that no such means existed, and that they would be obliged to abide their time and then trust to an operation for their relief.

It is difficult, indeed, to conceive how, in the existing state of physiological science—at all events, up to a recent period—any other opinion could be entertained. The lens is a transparent body inclosed in its capsule, without any vessels passing into it. How, then, was it possible to act on it by medicines?

It has been within a few years only that its mode of nutrition was understood. This is effected, as in some of the lower animals, by osmosis through its capsule.

I was first led to doubt the correctness of the doctrine under notice by the experiments of Dr. S. Weir Mitchell,[1] of this city, communicated to the Biological Society, Oct. 3, 1859, and published in the *Am. Jl. Med. Sci.*, for Jan. 1860. In experimenting with frogs by injecting syrup into their cuticular sac he found that the lens of the animal became opaque, and what was most remarkable that when the animal was replaced in water, after some hours the opacity diminished, and, in some instances, the transparency of the lens was entirely restored.

This last circumstance struck me as one which might lead to important practical results, and at all events it pointed out the direction in which our investigations should be made for that purpose.

Additional light was soon shed upon this subject by Dr. Richardson, of London, who, after reading Dr. Mitchell's paper, instituted a number of similar experiments, the results of which he communicated to the Medical Society of London on the 26th of March and 16th of April, 1860.[2] These experiments confirm Dr. Mitchell's results and throw much additional light on the subject. Dr. Richardson shows that cataract may be produced by the injection into the system not only of cane sugar, but also of grape and milk sugar—and likewise of glycerin, alcohol, of solutions of chloride of sodium, of acid urate of soda, and of lactate of soda. Death was also produced when any of these articles were introduced into the system in sufficient quantity.

Dr. R. concludes from his experiments that "as the cataractous appearance is modified by the density of the producing body, and is removable by

[1] On the production of Cataract in Frogs by the administration of sugar.
[2] See Am. Journ. Med. Sci., July, 1860, pp. 257–9.

reversing the conditions which led to it, and as it is producible in a clear lens removed from the body, it is a demonstration that the cataract induced in the different animals is a purely physical—that is to say, osmotic—change."[1]

Dr. Richardson advanced a step beyond this and suggested a practical application of this discovery.

"As a point bearing on the treatment of cataract," Dr. Richardson said, "that inasmuch as temporary opacity produced by exposure of the lens to syrup was removable by an after exposure to water (that is, by changing the position of the medium surrounding the lens), it was worthy of consideration whether an operation for letting out the aqueous humour by a small opening, and refilling the anterior and posterior chambers with distilled water, might not lead to removal of the cataractous condition in the earliest stages."

Soon after this, it was announced that M. Sperino, of Turin, had succeeded in curing cataract by repeatedly evacuating the aqueous humour. This was to some extent a confirmation of the value of Dr. Richardson's suggestion. M. Sperino was not led to this mode of treating cataract by any physiological reasoning, but rather empirically. "He had long derived great advantage from the repeated evacuation of the aqueous humour in cases of iritis, interlamellar keratitis, severe hypopion, staphyloma of the sclerotica, congestion of the choroid and retina (even when attended with exudations), opacities of the vitreous humour, and in pseudo-membranous deposits in front of the lens. Even in some desperate cases of glaucoma attended with commencing cataract, this treatment, useless as regards the loss of sight, was of use, a diminution of the opacity of the lens following the evacuation." M. Sperino promises to soon publish a work which will contain the results of his treatment of cataract by this method and show the kind of cataract to which this operation is applicable.

M. Sperino's operation consists in puncturing the cornea and preventing the puncture from uniting by introducing at short intervals into it a small probe, thus keeping up a drain of the aqueous humour. Mr. Hildige, of Dublin, professes to have tried this plan and without success; but he did not adopt M. Sperino's process. On the contrary, he made a fresh puncture at intervals, and these repeated punctures caused so much irritation and inflammation that he was compelled to desist.

These observations throw new light on the pathology of cataract, and seem to hold out a hope that remedial means may be discovered of arresting the progress of that disease, and, perhaps, even of restoring the transparency of the lens; but the physiological law which presides over the changes in the lens, and which was to guide us in our search for the means of controlling these changes, required to be more clearly determined.

In conversing, a short time since, with my friend Prof. Jackson on this subject, he informed me that experiments similar to those of Dr. Mitchell had been previously made by Kunde, and referred me to Claude Bernard's "*Leçons sur les proprietés physiologiques et les alterations pathologiques des liquides de l'organisme,*" for an account of them.

In M. Bernard's lecture, delivered on the 11th of Dec. 1857, that eminent physiologist, to whose experimental researches we are indebted for

[1] It is just to Dr. Mitchell to say that although he believed that the direct contact of the sugar with the lens was essential to the production of what he called sugar cataract, he recognized the fact that the phenomenon was produced by osmotic action.

many advances in physiological science, merely briefly notices Kunde's experiments, without stating when they were made. In that lecture he, however, treats of the physiological importance of water to the organism, and the doctrines which he there develops seem to me to afford a physiological explanation of the production of cataract and to point out the direction in which our investigation for the means of remedying that condition should be directed.

M. Bernard shows that water is an essential component of all living organism—it is the necessary vehicle for the materials which enter into the double movement of nutrition and excretion—without which life cannot be maintained. "Independently of their special properties, the organic fluids," he says, "are allied by a general character; all owe their first physiological importance to the water they contain; before being useful in consequence of the substances which they may hold in solution or in suspension, they are first useful as fluids."

M. B. states that water constitutes nine-tenths of the whole weight of the human body; but the proportion of water to the solid constituents varies in the different fluids, being from 80 to 90 per 100 in the blood; 98 to 99 per 100 in the gastric juice; 70 to 80 per 100 in milk, &c.

Mr. B. next investigates the influence which the quantity of water in the organism exercises on physiological phenomena. To do this, he says, "two processes present themselves to the experimenter; one consists in detracting water from the body, the other in adding water to it. The first is difficult to accomplish. Nevertheless, Dr. Kunde has effected this in frogs, and observed some singular results. His process consisted in introducing into the intestinal canal of these animals some sulphate of soda or sugar; endosmotic action was thus induced which caused a part of the water of the blood to flow into the intestine; the blood was thus deprived of a portion of its water."

"One of the first results of this experiment was the loss of transparency of the crystalline—the animal becoming blind. This result quickly disappeared when the frog was replaced in water. Convulsions also resulted from this impoverishment of the blood of its water, very probably from the subtraction of the fluids which bathed the nerve, and these convulsions disappeared when the water which the system has lost was restored to it."

M. Bernard injected water into the veins of dogs, thus increasing the normal proportion of water in the system, and found he could do this to a considerable extent, without ill consequences; but so soon as the proportion of water exceeded certain limits, pathological results followed. Some of the secretions were first diminished, and as more water was injected, these secretions became entirely suspended, convulsions then supervened, and finally death.

It is thus seen that while the proportion of water to the solid constituents of the blood may vary within pretty extensive limits, without injurious consequences, yet so soon as these limits are transcended, pathological conditions at once result.

The only one of these which at present interests us, is the opacity of the crystalline lens following the diminution of the proportion of water in the blood below its physiological limits.

Dr. Mitchell supposes that the direct contact of the sugar with the lens is essential to the production of the phenomenon in question; but this is disproved by the experiments of Kunde and Richardson, which show that other articles that cause excessive exosmosis of the fluids produce the same

phenomenon; and, further, Hepp, who examined a diabetic cataractous lens, extracted by Stoeber at the ophthalmological clinic of Strasbourg, could not find in it a trace of glucose.[1]

Dr. Mitchell states, that the mere abstraction of water from the lens is insufficient to cause opacity, because the lens when dried does not become opaque. This statement, we believe, requires some qualification, and at all events when excessive exosmose from the lens is produced, the superficial nucleated cells and lens tubes are as a consequence emptied of their contents, and the structure of the lens is thus so altered as to render this body more or less opaque. This vacuity of the nucleated cells and lens tubes has actually been observed by microscopists in the examination of cataractous lenses.

Is this opacity of the lens then the consequence of the impoverishment of the fluids of the body of their water, which causes an excessive exosmosis of the more fluid contents of the lens, and impairs the nutritive functions of that body?

There are a number of facts which seem to lend support to this view.

Cataract most commonly occurs in advanced life, at which period the proportion of fluids to the solids is considerably diminished, and as correctly observed by Mr. Dixon, when the lens becomes cataractous in old persons, "the change seems to consist in a process of drying and atrophy of its fibres."[2]

Again, it is now a well-established fact, that cataract is a frequent consequence of diabetes. Is this not to be explained by the abnormal density of the fluids of the system resulting from the excessive excretion of fluid by the kidneys; and if this opacity is not always produced, may it not be owing to the water being replaced by the great quantity ingested, uncontrollable thirst being a constant attendant on the disease?

M. Bernard states that it is difficult to deprive the organism of its water, but he has overlooked the fact that this may be effected by certain medicines, as croton oil, tartar emetic, and the hydragogue cathartics, and it is the constant result of several diseases, as diabetes, malignant cholera, profuse serous diarrhœa, leucorrhœa, &c.

In malignant cholera the exosmose of water into the intestines is enormous; the blood is so impoverished of its water that it becomes thick and dark as molasses. Is opacity of the lens one of the consequences of the loss of fluids in this disease? We are unable to answer this question, for we are not aware of any examination of the lens having been made after death from this disease. But we have often noticed a dulness and loss of transparency of the cornea, preceding death from this affection.

Artificial cholera may be produced by large doses of croton oil, or by repeated doses of emetic tartar, and experiments might be made on animals which would determine whether cataract is a consequence of the loss of fluid thus occasioned; and we would ask the attention of experimental physiologists to the subject.

Long continued copious serous diarrhœa, profuse leucorrhœa, and other exhausting fluid evacuations, impoverish the organism of its fluids, and, if our views be correct, must favour the formation of cataract.[3]

If it be objected to this that no such result has ever been noticed, let it

[1] Lecorché, *Archives Gen.*, May, 1861, p. 737.

[2] Guide to the Practical Study of Diseases of the Eye, 2d ed., p. 216.

[3] There may be various other obscure diseases, which also alter the normal density of some of the fluids, and thus impair osmotic action.

be remembered that it is only within a very few years that the connection between diabetes and cataract has been recognized, and that when attention shall be directed to this subject a similar connection may be discovered in other affections.

Should further investigations show that the long continued impoverishment of the blood of its water impairs the osmotic nutritive functions of the lens so as to produce opacity of that body, may we not hope that in some of such cases, by supplying to the organism its lost water, or by adopting the suggestion of Dr. Richardson or the practice of M. Sperino, the nutritive actions of the lens may be restored, the progress of the opacity arrested, and even, as occurred in the experiments of Kunde, Mitchell, and Richardson, that its transparency may be restored.

In very advanced age, it may not be possible to restore the proportion between the fluid and solid constituents of the body, for to do this would be to rejuvenate the individual, and senile cataract may therefore be regarded as beyond our therapeutical resources, as will be also those cases in which the affection has advanced to that stage where the lens tubes have become broken up and actual structural alterations have taken place.

Congenital and traumatic cataract must be equally intractable to medical treatment, neither resulting primarily from impaired nutrition. The former is the consequence of arrest of development; and the latter is produced by exudation of lymph on the capsule, the result of inflammatory action. The capsule is then, of course, rendered incapable of performing its osmotic functions.

But when cataract occurs prior to senility—without any obvious cause—when the opacity has not far advanced, and especially when the impaired nutrition causing the opacity, is the sequel of exhausting evacuations, is it unreasonable to hope that the progress of the change in the lens may be arrested, and even a retrograde metamorphosis effected?

The loss of transparency of the lens almost always commences in the layer of nucleated cells which connect the body of the lens to its capsule, the anterior marginal cells being first affected—the opacity proceeds in a centripetal direction implicating next the superficial softer fibres, and it is usually not until a late period that the denser fibres constituting the nucleus become affected. The mere arrest of the affection in its early stages while the nucleus is still clear, would be a great boon to the patient.

We might dwell further on this subject, for many points remain still to be developed, but we abstain for fear of too long trespassing on the patience of the Fellows of the college.

We shall besides have accomplished our object if we have succeeded in awakening attention to the subject, and have thrown some light on the pathology of cataract—if we have excited the suspicion of our hearers that the conviction under which we have long rested of its being beyond the therapeutic resources of our art to retard, or in any degree control the formation of cataract, may not be well founded, and if we have indicated the proper direction in which our researches should be pushed in order to discover the means, if such exist, of attaining this very desirable object.