Address.

THE ADVANCEMENT OF MEDICINE BY RESEARCH.[1]

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THE recent attempt by the Society for the Prevention of Cruelty to Animals to secure legislation for the restriction of biological research in Massachusetts, and the probability that the attempt will be repeated during the next session of the Legislature, may serve as my excuse for asking you to consider the history and significance of the movement, the inevitable result of its success, as well as the moral principles which here find their application.

That the Legislature of Massachusetts should be requested to restrict the right of physicians to study their profession, and of the higher educational institutions of the State to teach the sciences on which the practice of medicine rests, is a phenomenon which surprises no one who has watched the progress of the so-called "antivivisection" agitation during the last quarter of a century. At various times within this period have the efforts of misguided benevolence been directed to checking the progress of medical science by interfering with one of the most important methods by which advances can be made. Fortunately for humanity these efforts have, in nearly all cases, been rendered futile by the sound common-sense of the community. In England alone, of all civilized countries, has a certain measure of success crowned the efforts of the fanatical agitators, and by the enactment of a restrictive law a serious blow has been inflicted upon English physiology.

In the presence of such an agitation it is, of course, to the members of the medical profession that the community, distressed by the constant repetition of tales of imaginary atrocities, will naturally turn for the assurance that teachers of the medical sciences are not brutes and criminals, and that medical students are not young ruffians who delight in blood and suffering. It is, therefore, important that physicians should be at all times ready to explain to the laity how, as Dr. J. G. Curtis has happily expressed it, "in the slowly woven fabric of achievement pure science and applied science, biology and medicine, have always been warp and woof."

It requires no professional training to comprehend that a knowledge of the bodily functions in their normal state is essential for the understanding and treatment of those derangements of function which constitute disease, and that physiology, which deals with these normal functions, must, therefore, form the basis upon which medical science and medical practice alike must rest. Now nearly all the phenomena of life which form the subject-matter of physiology are either physical or chemical in their character. In fact, physiology must be regarded as the physics and chemistry of living bodies. Therefore, just as the physicist and the chemist build upon the basis of experiment the solid superstructure of their sciences, so the physiologist can hope to advance firmly and successfully to the discovery of the laws of life only on the condition that the same experimental method supplies the stepping-stones for his progress.

[1] The Annual Discourse before the Massachusetts Medical Society, delivered at the One Hundred and Fifteenth Anniversary, June 10, 1896.

Self-evident as this proposition seems to the student of nature's laws, certain persons are ready to deny the legitimacy of the experimental method of research when applied to living bodies, while they admit it to be absolutely indispensable in the case of non-living matter. The cause of this attitude of mind is not difficult to discover. In fact, it has its origin in the noblest feelings of human nature, in the sentiment that bids us be merciful as we would obtain mercy. Those who hold these views, profoundly impressed by what they conceive to be the painful nature of experiments performed on living animals and by the alleged indifference to animal suffering shown by the experimenters, have not hesitated to bring charges of cruelty against those who are engaged in seeking to penetrate the mystery which still surrounds the actions and reactions of living organisms, and thus to lay, broad and deep, the foundations on which the medical science of the future is to be built up.

I have used the words "misguided benevolence" in speaking of this agitation, and there is no doubt that many, though unfortunately not all, of the persons engaged in this crusade are benevolent in their disposition and conscientious in their attitude; but it should be remembered that, as Mr. Roosevelt recently remarked, "Conscience without common-sense may lead to folly, which is but the handmaiden of crime."

In judging of the moral and mental attitude of those who are engaged in this mischievous agitation, it is important to distinguish carefully between the leaders and the followers. The former are fortunately very few in number, but by their activity and apparent ubiquity they easily create an impression of being in much larger force. Dominated by the single idea that vivisection is "an abominable thing and hateful in the sight of God," they presume to teach lessons of humanity to the members of a profession which exists for the relief of suffering. Unable to comprehend the reports of biological investigations published for professional readers, they recklessly denounce perfectly painless experiments as cases of fiendish torture. Deliberate and authoritative statements setting forth the necessity of animal experimentation for the advancement of medical science, the vast amount of good already accomplished, and the comparatively trifling amount of the suffering involved, are treated simply as falsehoods such as might naturally be expected from the "cowardly criminals" who practise vivisection.

This movement is, therefore, by no means to be regarded as a simple humanitarian effort to reduce to a minimum the amount of animal suffering connected with vivisection. Restrictive laws like that of England are denounced as useless, and the total abolition of the practice is imperatively demanded. That this will have the effect of seriously checking the advance of medical science some of the leaders ignorantly deny, while others contemplate this result with satisfaction, for they deny the right of the human race to profit by animal suffering, and condemn the saving of a human life by the sacrifice of that of a dog. That this is not an exaggerated statement of the position assumed by antivivisectionists, a single quotation from the writings of Henry Bergh will suffice to show. Mr. Bergh was for many years president of the New York Society for the Prevention of Cruelty to Animals, and was throughout his life the acknowledged leader of the antivivisectionists in America. In a lecture on this subject, after describing the experiments of Dr. Robert

McDonald, who successfully practised the transfusion of animal blood into the veins of a dying person, Mr. Bergh comments as follows: "In other words, this potentate has discovered the means of thwarting the decrees of Providence where a person was dying, and snatching away from its Maker a soul which He had called away from earth." It seems to me that this blasphemous denunciation of a physician for saving a human life needs absolutely no comment.

It might naturally be supposed that such extravagances of statement would carry their own refutation and would demand no more attention from serious people than the utterances of those medical philosophers who deny the utility of vaccination. Acting upon this supposition, and unmindful of the fact that lies travel faster than truth, biological investigators have, as a rule, not thought it necessary to contradict specifically the various misstatements which have been published with regard to their work. The result has been that certain excellent people, of emotional dispositions and without the special training which would enable them to judge correctly of such a question, have been led to believe that where there is so much smoke there must be some fire. They have, therefore, by joining antivivisection societies, lent the weight of their names and their purses to a movement fraught with danger to the welfare of the State. That members of our own profession have occasionally expressed themselves in a way to encourage this agitation is to be deplored, but not wondered at, for no one listens more sympathetically to a tale of suffering than a true, tender-hearted physician; and, if he does not happen to be in a position to contradict from his own knowledge the heart-rending stories which are poured into his ears, he may be readily convinced of the existence of abuses requiring legislative interference.

Recognizing the true nature of the antivivisection agitation, it is evident that educated physicians would be false to their high calling did they not resist with all their energy the attacks of an enemy whose success would destroy all hope of establishing medicine in the position to which it is rightfully entitled, the most important branch of biological science.

In thus maintaining their right to study and teach their profession, physicians are not called upon to maintain that unnecessary pain has never in the history of the world been inflicted in connection with vivisection. Their true contention should be:

(1) That the men in charge of the institutions where vivisections are practised in this State are no less humane than those who desire to supervise their actions, while they are at the same time vastly better informed with regard to the importance of animal experimentation and the amount of suffering which it involves.

(2) That no abuse of the right to vivisect has been shown to exist in these institutions.

(3) That the governing bodies of these institutions possess both the will and the power to put a stop to such abuses should they arise.

(4) That the existing statutes furnish sufficient protection against cruelty in vivisection as well as against cruelty in general.

(5) That for the reasons above given legislation on this subject is wholly uncalled for.

These propositions define substantially the position assumed by this Society in the resolution adopted four years ago in response to a communication from the Massachusetts Society for the Prevention of Cruelty to Animals, and, with the medical profession united in their defence, no fear need be felt that our Legislature will ever yield to the pressure of fanatical agitation, to the detriment of the best interests of the community.

A full account of the origin and progress of the antivivisection agitation would, of course, be impossible within the limits of this discourse; but it will be well to refer briefly to the history of the movement in other communities, calling attention to certain points which are full of instruction and warning for ourselves.

The first serious attack upon biological research in England seems to have been made in an essay entitled "Vivisection, is it Necessary or Justifiable?" published in London in 1864 by George Fleming, a British Army veterinary surgeon. This essay is an important one, for, though characterized at the time by a reviewer in the *London Athenæum* as "ignorant, fallacious and altogether unworthy of acceptance," its blood-curdling stories, applied to all sorts of institutions, have formed a large part of the stock in trade of subsequent antivivisection writers.

A fresh stimulus to the agitation was given by the publication in 1871 of a work edited by Prof. J. Burdon Sanderson, entitled "Handbook for the Physiological Laboratory." This book was intended to be used by students of physiology under the guidance of their instructors and contained a description of the experimental basis on which modern physiology rests. Unfortunately, however, it fell into the hands of excitable men and women who were ignorant of many things which had properly been taken for granted in writing for members of the medical profession. That anesthetics, for instance, would be used in all cases to which they are applicable was tacitly assumed, just as it would be in a work on operative surgery. In consequence of this failure to comprehend the object for which the book was written, many well-meaning, but too impulsive people jumped "to the conclusion that raw medical students were being encouraged to repeat for their pleasure every experiment that had ever yielded results, careless whether the subjects were conscious or unconscious of pain." This misconception tended to produce an excited state of popular feeling which was intensified by the performance at the meeting of the British Medical Society in 1874 of some experiments on dogs, showing the difference between alcohol and absinthe in their physiological action. The excitement culminated in the appointment of a Royal Commission to inquire into the subject. The result of the investigation was a report which cannot be better described than in the language of Lord Sherbrooke (better known as the Right Honorable Robert Lowe): "The commission entirely acquitted English physiologists of the charge of cruelty. They pronounced a well-merited eulogium on the humanity of the medical profession in England. They pointed out that medical students were extremely sensitive to the infliction of pain upon animals, and that the feeling of the public at large was penetrated by the same sentiment. They then proceeded to consider to what restrictions they should subject the humane and excellent persons in whose favor they had so decidedly reported. Their proceeding was very singular. They acquitted the accused and sentenced them to be under the surveillance of the police for life." Remarkable as was this conclusion of the com-

mission, the action of Parliament based upon it was still more extraordinary, for a law was enacted, which, taken in connection with previous legislation, has brought about a state of things in England which has been well described as one "in which it is penal to use domestic animals in any way cruelly, but in which any one may torture wild creatures in whatever fashion he likes, *provided it is not for scientific purposes.*"

The amount of mischief which may be produced by this English law depends very much upon the good judgment of the Home Secretary, to whom its enforcement is entrusted. The most eminent members of the medical profession in England have at times been refused a license to perform experiments which they declared to be of the greatest importance for medical science, and in general it may be said that the system of licensing and government inspection under which biological research work must be conducted, is, under the most favorable conditions, a source of serious annoyance to investigators, while it does not secure any better guarantee for the humane treatment of animals than is afforded by the character of the men engaged in the work.

The system, moreover, fails entirely to satisfy the antivivisectionists, who, in support of their demand for a prohibitory law, continually circulate the most exaggerated and perverted accounts of experiments performed in licensed and inspected laboratories.

The first outbreak of the antivivisection agitation in this country occurred in New York some sixteen or seventeen years ago, when the State Society for the Prevention of Cruelty to Animals, under the leadership of Henry Bergh, attempted to secure the passage of a law prohibiting the practice of vivisection. The agitation was conducted with so much fanaticism and the method of garbled quotation employed by Mr. Bergh was exposed so effectively by the late Dr. J. C. Dalton in the columns of the *New York Nation*, that the Legislature not only declined to enact any restrictive laws, but maintained in full force an amendment to the general law against cruelty to animals adopted in 1867, providing that "nothing in this act contained shall be construed to prohibit or interfere with any properly conducted scientific experiments or investigations, which experiments shall be performed only under the authority of the Faculty of some regularly incorporated medical college or university of the State of New York."

New York has thus set an excellent example to her sister States in protecting her men of science, in their attempts to enlarge the bounds of human knowledge, from the vexatious interference of persons who can know nothing of the importance of the work or of the amount of suffering which it involves.

In Pennsylvania, also, attempts have been made to secure restrictive legislation by the American Antivivisection Society, which has its headquarters in Philadelphia, but the energetic protests of the medical profession have sufficed to render these attempts abortive.

In Washington, during the present session of Congress, the efforts of the local humane societies have been so far successful that the Committee on the District of Columbia has brought before the Senate a bill providing for the licensing and restricting of vivisection, but there seems to be little reason to fear that such a bill can ever become a law.

In Massachusetts the State Society for the Prevention of Cruelty to Animals has, until quite recently, treated this question with moderation and good sense. While regretting the necessity for sacrificing animal life for the advancement of science, and anxious, like all right-minded people, to reduce the sufferings of such animals to a minimum, it has not seen in the existing state of things any reason for demanding additional legislation or for taking any action under laws already in force. A few years ago the president of the society publicly called attention to the failure of the antivivisection agitation, both in this country and in Europe, to effect any material reduction in the number of animals subjected to experiment, and maintained that the proper attitude of the society should be one of co-operation with the best men of the medical profession in seeking to prevent any abuses from arising in connection with the practice of vivisection. To the friends of the society who rejoice in the good work it has been able to accomplish in the community, it must be a matter for sincere regret that this wise policy has been abandoned, and that the society now finds itself arrayed in opposition not only to the medical profession, but also to the higher educational institutions of the Commonwealth. It is, however, but just to state that this position has been assumed without any formal action by the governing body of the society.

The bill first presented by the society to the Legislature of 1896 provided that no painful experiments upon living animals should be performed in any educational institution of the State, except under the authority of the State Board of Health, and that the Massachusetts Society for the Prevention of Cruelty to Animals might supervise all such experiments. Violations of the law were to be punished by fines which, when collected, were to be turned over to the society.

During the hearings before the Judiciary Committee of the House this bill was twice modified, first by the omission of the section relating to the State Board of Health and of the clause requiring the fines to be paid into the treasury of the society, and subsequently, by providing that the agents of the society employed to supervise vivisections should be doctors of medicine. The petitioners for this legislation were, one after another, compelled to acknowledge under cross-examination, that they were unable to present any evidence of cruelty practised in the educational institutions of Massachusetts in connection with vivisection, while the remonstrants, by a straightforward account of what actually occurs in physiological laboratories and by an exposure of the exaggerations and misstatements with which antivivisectionist literature abounds, sought to convince the committee of the mischievous character of the agitation and of the unfortunate results which would necessarily follow the proposed legislation. Shortly after the close of the hearings the committee presented a unanimous report, recommending "that the petitioners have leave to withdraw."

Having thus endeavored to present a few salient points in the history of the antivivisection movement and to indicate the methods employed by the leaders of this crusade against the work of a profession whose glory is to save, let me next ask you to consider the reasons which not only justify students of medical science in resorting to experiments upon living animals, but require them to do so as a necessary condition of any important advance.

In dealing with this question I shall make free use of a work entitled "Physiological Cruelty, or Fact *vs.* Fancy," by Philanthropos. This book, which appeared in 1883, contains by far the most comprehensive, logical and dispassionate discussion of the subject with which I am acquainted.

The vivisection question reduced to its simplest expression may be stated as follows: "Have we a right to give pain to animals in order to study the phenomena of life?" In answering this question we perceive at once the necessity of a clear conception of what pain really is; and in striving to obtain this conception, we are struck with the fact that pain is a purely subjective phenomenon. We know absolutely nothing about pain except that which we have ourselves suffered. We infer, of course, when we hear another person describe a painful sensation that his feelings are similar in a general way to those which we imagine we ourselves should experience under like circumstances. This assumption of similarity of sensation is justified by the facts of our common human nature; but we are often struck, when listening to such descriptions, by the apparent difference between the impressions produced upon different individuals by the same external cause. A trifling surgical operation, which will not be considered worth mentioning by one individual, will to another be, apparently, the source of most acute suffering. We are thus led to suspect that, even in the circle of our own acquaintances, there must be quite a wide range of sensibility to pain. If we extend our observation over a wider field, we find reason to believe that in the human race there is a certain rough proportionality between sensibility to pain and intellectual development. A case is recorded, for instance, of a Russian serf who, while splitting logs in a forest, was caught by the thumb in the crack of a large log from which the wedge had unexpectedly flown out. He tore himself free from his painful imprisonment, as a wild animal might have done, leaving the thumb in the log with the long tendons of the forearm still attached to it. It is doubtful if a more civilized man could have subjected himself to this operation even with the alternative before him of an indefinite imprisonment in the forest. The cruel tortures which savages inflict upon their friends and themselves, as in the initiation rites of the Mandan warriors, seem to be best explained on the supposition that their sensibility to pain is less acute than that of civilized races.

In the case of the lower animals the evidence of a low sensibility to pain is much more conclusive. Among our domestic animals the horse and dog are commonly regarded as standing nearest to man in intelligence and sensibility, and yet nearly every one who has had much to do with these animals will recall instances of great indifference shown by them to what would be to us severe pain. A single illustration of this insensibility may suffice. A horse whose leg was badly broken was sentenced to be shot, but during the two hours which intervened between the sentence and the execution the animal limped about to graze, dragging the fractured limb dangling behind it in a way which would have caused a human being exquisite agony. It is evident, therefore, that it is entirely impossible to draw conclusions with regard to the sensations of animals by an effort to imagine what our own would be under similar circumstances.

Our common human nature, which serves as a guide, though an imperfect one, in estimating the sufferings of other human beings, fails us entirely when we have to do with animals, and we are left to draw conclusions from cries, motions and other external signs of suffering. Now these external signs are apt to be misleading, for they only prove "that something is going on which the organism repels," but do not prove that the animal is conscious of what is going on. In other words, the cries and struggles of an animal whose skin is cut or burnt belong to that class of phenomena known as "reflex actions"; that is, they are movements having their origin in impressions made on the terminations of the nerves and not in impulses coming from the nerve centres in the brain. They may be accompanied by consciousness; but consciousness, so far from being necessary for their production, acts rather to check and interfere with their manifestation.

We are all perfectly well aware that, when the spinal cord of an animal has been divided in the cervical region, an impression made upon the nerves of the skin, either by a sharp instrument or a chemical irritant, will cause the animal to execute violent movements of very definite character, adapted to remove the source of irritation and differing in no respect, except perhaps in increased energy, from the movements of a perfectly uninjured animal. But in this case we know that the movements are not attended by consciousness, for, by division of the spinal cord, the channel by which impressions are conveyed to the nerve centres whose activity is a necessary condition of consciousness is entirely obliterated. The movements are, in fact, no more indicative of suffering than are the convulsible flutterings of a decapitated chicken. We can speak with great positiveness upon this point, for the testimony of hospital patients suffering from injuries to the spinal cord shows clearly that violent reflex movements of the lower limbs may occur absolutely unattended by consciousness. It is, moreover, a matter of common experience that in certain stages of anesthesia consciousness may be entirely abolished, while the activity of the lower reflex centres remains unaffected. In such cases patients may struggle and scream during an operation, but subsequently declare that they have suffered no pain.

It is evident, therefore, that great caution must be exercised in drawing conclusions with regard to the sensations of animals from the external signs of suffering which they manifest when undergoing operations, and that the "spasm of agony" of sensational writers is, in most cases, much better described as a nerve-muscle reaction.

We have thus seen that for the production of a painful sensation three things are necessary:

First, the stimulation of a sensory nerve.

Second, the transmission of the stimulus to the nerve centres whose activity is associated with consciousness.

Third, the response of these nerve centres to the stimulus thus received.

Pain may then be defined as the *consciousness of the excessive stimulation of a sensory nerve.* This definition excludes those cases in which the brain is narcotized or separated from the rest of the nervous system so that there can be no consciousness of the stimulation of the nerve, however severe it may be, and also those cases where the stimulation of the nerve is moderate in amount and therefore gives rise to agreeable

sensations. The precise point where the stimulus of a nerve ceases to be moderate and agreeable and becomes excessive and painful cannot be determined with precision, for a stimulation which is moderate for one individual will be excessive for another, or for the same individual at a different time. The strong alcoholic liquor, for instance, which pleasantly titillates the throat of a drunkard will sear the delicate mucous membrane of the child unaccustomed to its use.

Having thus arrived at a definition of pain, and noted that the phenomenon in man and the lower animals is similar in kind though vastly different in degree, we recur to the original question, Have we a right, in studying the phenomena of life to inflict upon animals whatever pain may be necessary for the attainment of our object? This leads us to consider the broader question, how far it is right that one individual should suffer for the good of another, and this, again, involves the still broader problem, how far the prospect of future good may compensate for present evil. A full discussion of these questions would carry us far beyond the limits of this discourse. For our present purpose it will be sufficient to note the fact that we unhesitatingly submit ourselves and subject those we love to physical suffering for the sake of future benefit which we think will outweigh the present pain. Nor is this deliberate choice of present evil for the sake of future good limited to those cases in which the evil and the good are both experienced by the same individual. The law of vicarious suffering by which pain to one individual secures pleasure to another is a law from whose operation we cannot escape if we would; and, however much we may at times rebel against it, a calm consideration forces us to recognize its stern beneficence. The law which bids us bear one another's burdens and that which declares that the sins of the fathers shall be visited upon the children tend powerfully to bind the human race together and contribute perhaps more than any other causes to the development of the moral sense. We see, then, that there is nothing repugnant to our moral feelings in the abstract idea that one individual should suffer for the benefit of another; and, if we accept this principle, as indeed we *must*, when applied to two individuals belonging to the highest grade of sentient creatures, there is still less reason for rejecting it when the suffering individual belongs to a lower grade than the individual who is benefited, since, for the reasons already given, the suffering in this case bears a smaller proportion to the benefits obtained than when both individuals are equally highly organized. Moreover, when the sufferings of the lower animals have, as a result, not a benefit to a single individual but an increase of human knowledge, the disproportion between the suffering and the benefit becomes practically infinite, for the suffering remains a constant quantity, while the benefit, since it accrues to the whole human race and through all time, is multiplied by an infinite factor.

(To be continued.)

An Irate Female. — A female medical student, says the *Medical Record*, who failed at a recent examination in London so effectually lost control of her inhibitory moral sense as to retaliate in the following ungrammatical convulsive outburst: "Very soon doctors will be drawn from we pure, noble-minded women, and you vile, drunken, filthy men expelled forever."

Original Articles.

CASES ILLUSTRATING RENAL SURGERY.[1]

BY F. S. WATSON, M.D.

Case I. Impacted ureteral calculus. Exploratory laparotomy and lumbar incision. Subsequent formation of retro-peritoneal abscess. Recovery, with entire relief of all symptoms.

November 18, 1894. Boston City Hospital, Ward B. Male, aged forty-three.

Obstinate constipation for many years. Gradual loss of appetite and flesh for three years. Three months ago, severe attack of pain in the region of the vermiform appendix. Pain was paroxysmal, and there was marked tenderness at McBurney's point. Retention of urine occurred simultaneously, requiring use of a catheter for forty-eight hours. Catheter cystitis resulted, lasting one month. Previous to this attack there had been no bladder symptoms. Symptoms of appendicitis ceased after two days.

Patient was discharged well six weeks after entering the hospital. Two weeks later he began to have intermittent dull pain below the tip of the eleventh rib on the right side. The pain shifts occasionally to a point midway between the eleventh rib and the crest of the ilium; it has gradually increased in severity, and at times has been very acute; bladder irritability has generally been associated with these attacks, and the urine is greatly diminished in quantity. In the intervals the quantity invariably increased. The smallest amount in twenty-four hours was eight ounces; it has been frequently as small as sixteen ounces. The largest amount was fifty-two ounces, which was passed three days consecutively. Specific gravity ranged from 1.018 to 1.025. There was occasionally a slight trace of albumin, and a few hyaline casts were found in the sediment. A few red blood-corpuscles were also noted, but no crystals were found at any time. At no time during an attack of pain could the amount of urine be increased by diluents or diuretics.

The patient is incapacitated by the attacks of pain, although he has not lost much flesh or strength. He has no appetite, is pale, and slightly icteric; during the attacks of pain the bowels are obstinately constipated, in the intervals there is marked relief from this.

A provisional diagnosis of ureteral calculus was made.

Operation, November 18, 1894. An incision three inches in length was made through the linea semilunaris extending upward from a point opposite to the anterior superior spine of the ilium.

Through this wound the ureter was explored. At its point of crossing the iliac vessels, a small stone was detected; while examining it, it slipped from beneath the finger, but was presently felt again.

A lumbar incision parallel with the border of the quadratus lumborum was made with the intention of extracting the stone extra-peritoneally through an incision in the ureter, or of pushing it onward into the bladder, but while trying to accurately locate and fix the stone in the ureter, it again slipped and could not be found.

The patient's condition now became critical, and both wounds were closed as quickly as possible. The

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BY HENRY P. BOWDITCH, A.M., M.D.,
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(Concluded from No. 24, p. 581.)

Admitting then that there is no abstract reason why animals should not suffer for the benefit of man, it remains to be considered whether we have a "right to constitute ourselves administrators of this law of vicarious suffering and to apply it to animals for our own interest." The right of man to inflict pain upon the lower animals for his own benefit has never been very distinctly formulated. Our relations to the wild denizens of the forest, field and stream are very largely an inheritance from those times when our savage ancestors disputed with the lower animals for the right to exist on the face of the earth. In fact, they do not differ materially, except in degree of complication, from the relation of the lion to the lamb or the hawk to the dove.

In the words of the author of the above-mentioned work on "Physiological Cruelty": "It is generally admitted that we may chase and kill an animal, often necessarily with much pain, not because its life and liberty interferes with ours, but because its death will render our life more complete, perhaps in the most trivial detail. We kill them (without anesthetics), not only that we may have food and clothing, but that the food may be varied and attractive and the clothing may be rich and beautiful. We subject them to painful mutilations in order to make them more manageable for service, to improve the flavor of their flesh, and even to please our whimsical fancies. We imprison them in cages and zoölogical gardens, to improve our knowledge of natural history or merely to amuse ourselves by looking at them. It is abundantly clear that in all our customary dealings with animals we apply to them without scruple the law of sacrifice, and interpret it with a wide latitude in our own favor. . . . So far, the general principle of dealing with animals which is in a vague way accepted by most humane persons . . . seems to be that we may kill, inconvenience or pain them, for any benefit, convenience or pleasure to ourselves, but that the pain must be within moderate limits (of course undefined), and that it must form no element in our pleasure." Now the point to be especially emphasized in this connection is that physiologists, in experimenting with living organisms, cause an amount of suffering utterly insignificant compared with that which animals are called upon to endure in other ways and that the suffering thus caused is inflicted with a motive and with an expectation of benefit quite adequate to justify the infliction of a much greater amount of pain than even the most serious operations in the laboratory can be supposed to produce.

In this respect the physiologist stands, it seems to me, on higher moral ground than that occupied by most persons whose occupation leads them to sacrifice animal life. Compare, for instance, the occupation of a sportsman with that of a physiologist. It is difficult to imagine how an animal such as a deer or a rabbit can be made to endure greater physical agony than in being hunted to death by hounds. It is hard to conceive of animal suffering more entirely out of proportion to the object sought and gained by it than that produced by the average sportsman whenever he fires a charge of shot into a flock of birds, since, for every bird actually killed, several more will probably be wounded and, escaping with broken limbs, fall an easy prey to their enemies or perish from starvation. Yet we inflict this suffering, not because we need the animal for food, not because its existence interferes in any way with our own, not because we expect to derive any permanent benefit from its destruction, but simply, as the word "sport" implies, because we are in search of amusement and the sufferings of the animal are incidentally associated with our enjoyment of the moment. It must not be supposed that I desire to bring the charge of cruelty against sportsmen, for, of course, the fact that the animal suffers pain forms no part of the pleasure of the hunter; nor do I overlook the great benefit which the sportsman derives incidentally from his pursuit in the acquirement of health, strength and skill. I merely wish to point out, first, that as far as the charge of cruelty is concerned, the physiologist may claim the same exemption which is accorded to the sportsman, for, so far from enjoying the sufferings of the animals on which he experiments, it is his constant object to reduce those sufferings to a minimum; and, secondly, that with regard to a justification for the infliction of pain, the advantage is on the side of the physiologist, for the desire to enlarge the bounds of human knowledge and to fix firmly the foundations of the healing art must be regarded as a higher motive than the wish to secure one's own temporary amusement, and, moreover, the proportion between the benefit obtained and the pain inflicted is much larger in physiological experimentation than in the vocation of the sportsman.

In this connection it is interesting to contrast the fate of the victims of science with that of similar animals living in a state of nature. In doing this we are struck by the vast amount of animal suffering which the laws of nature necessitate. The weak are inevitably the victims of the strong. The chain of destruction extends throughout the animal creation, and every link involves the death of victims under circumstances which from a human point of view seem those of revolting cruelty. The cat plays with the mouse, apparently enjoying its terror and distress. The butcher-bird impales its living victims on the thorns of the locust tree, thus laying up in its hideous larder a store of food often far beyond its needs. The larger carnivora tear their living prey limb from limb. In fact the relations of animals to each other are such as to fully justify, from a moral standpoint, an indictment for cruelty against Nature herself. With regard to domestic animals the case is often not much better. The vagrant cur and the prowling cat lead a life of constant terror, eking out a miserable existence amongst piles of garbage, and dying finally, when physical strength fails, from sheer starvation. Compared with misery like this the fate of the chosen victim of science may well be regarded as enviable, for once within the laboratory precincts warmth and abundant food are assured and, though the term of life is shortened, its closing scene is often absolutely painless and is, in any case, likely to be attended with less suffering than a so-called natural death.

With regard to physiological experiments which in

[1] The Annual Discourse before the Massachusetts Medical Society, delivered at the One Hundred and Fifteenth Anniversary, June 10, 1896.

volve operations of a painful nature upon living animals, it is important for us to ascertain as accurately as possible the amount of suffering thus caused. The first important fact to be here noted is that the great boon conferred upon mankind in the discovery of anesthetics extends its beneficent influence over the animal world as well. Just as no modern surgeon ever thinks of performing a severe surgical operation without placing the patient under the influence of ether or chloroform, so no physiologist neglects to use an anesthetic when performing a prolonged or painful experiment except in those rare cases in which its administration would interfere with the result of the experiment. Even on the supposition, which too many sensational writers are prone to make, that a physiologist is absolutely regardless of the amount of suffering which he causes, he will still be compelled to use an anesthetic for his own convenience in order to suppress the cries and struggles of the animal which would otherwise disturb the adjustment of his delicate instruments and interfere with the mental concentration essential for the proper performance of his work. This very concentration of the mind upon the work in hand prevents, of course, any active feeling of sympathy with the animal experimented upon; but the same may be said of the surgeon who, however tender-hearted he may be, never in operating allows his mind to wander from the work in which his hands are engaged. Neither the one nor the other can be charged with cruelty or inhumanity.

In this connection it may be well to allude to the question whether curare, a drug frequently used by physiologists, is or is not an anesthetic. This substance is the arrow poison of certain tribes of South American Indians and has the property of paralyzing the voluntary muscles. The earlier experiments of Claude Bernard on frogs, showing that sensory nerves are not affected by the poison, led him to the conclusion that an animal poisoned by curare preserves his sensibility to pain, but has lost the power of giving any sign of suffering. Strictly speaking Bernard's experiments only show that the drug affects the sensory nerves and the spinal cord less readily than the motor nerves, while they throw no light on the question of the persistence of consciousness, but the fact that they succeed equally well after the removal of the cerebral lobes seems to exclude consciousness from any important participation in the phenomena. The arguments which have sometimes been used to sustain the proposition that curare increases the sensibility to pain would prove also that small doses of morphia have the same effect, whereas we know that morphia in small doses diminishes and in larger doses annihilates the sensibility to pain. Thus the weight of physiological evidence seems to be in favor of the view that curare may be to some extent an anesthetic, though it is not employed by physiologists for that purpose. Psychological evidence pointing in the same direction may also be urged, for, on the theory promulgated and ably defended by Prof. Wm. James, that all emotions are but the conscious recognition of the reflex-actions produced by the exciting cause of the emotions, it seems evident that so much of the substratum of the feeling of pain as is dependent upon the reflex contraction of voluntary muscles must, in cases of curare poisoning, be absolutely wanting.

Of the possibly painful physiological experiments which we are now considering, it has been calculated by Professor Yeo that seventy-five per cent. are rendered absolutely painless by the use of anesthetics; but it must, however, be admitted that the giving of an anesthetic to an animal is not the same agreeable operation that it is to a human being. The animal does not understand the reason why it is compelled to breathe a vapor which is gradually depriving it of its consciousness and usually struggles against the administration of it, thus rendering some sort of forcible confinement necessary. The inconvenience thus occasioned to the animal is, of course, overbalanced in the case of prolonged or serious operations by the exemption from subsequent suffering. When, however, the operation is of a trifling character it is doubtless more merciful to the animal to dispense with the use of anesthetics. For the complete understanding of this portion of the subject it should be mentioned that a large portion of the animals thus rendered insensible for physiological purposes are killed after the experiment has been performed and before the effect of the anesthetic has passed off. Where the object of the research is to observe the subsequent effect of the operation it is, of course, necessary to allow the animal to recover from the anesthetic and to endure whatever pain may be connected with the healing of its wounds. This has, however, been reduced to insignificance by the modern methods of antiseptic surgery, the discovery of which was led up to by physiological experiments and the benefits of which are now experienced by the brute creation as well as by the human race.

Accepting Professor Yeo's estimate that seventy-five per cent. of the possibly painful physiological experiments are rendered absolutely painless by the use of anesthetics, it remains to be considered how much suffering attends the remaining twenty-five per cent. of these experiments; and here it is important, in all discussions of this subject, to correct a rather prevalent popular notion that a wound is painful in proportion to its depth. The fact is, however, that sensibility to pain is, in a healthy body, confined almost wholly to the surface. A consideration of the function of the sensory nerves shows us why this should be the case, for these nerves are only distributed to points where under normal circumstances they can receive stimulation and thus serve to bring the organism into relation with the outer world. Pain, caused by excessive stimulation of a sensory nerve, is the sign that the integrity of the body is threatened by some external agency, and at this signal the body reacts consciously or unconsciously to ward off the threatened danger. Now external agencies can act upon the body only at the surface. Hence sensory nerves distributed to internal organs would have no *raison d'être;* and, in the wise economy of nature, we find, accordingly, that they do not exist. The apparent contradiction to this statement furnished by the painful sensations — for example, cramps and colics — which we sometimes experience in our internal organs are really illustrations of the same general law, for the pain in this case is the indication of some *morbid* action of an organ, and is usually the sign that rest is necessary to enable the organ to recover its normal condition. It is a matter of common experience, therefore, that the cutting of the skin is the only really painful part of even quite serious operations. As the knife divides the deeper organs no pain is felt, except indeed when a sensory nerve-trunk is divided,

which operation is attended by a momentary flash of pain. Even the brain, the seat of consciousness itself, is no exception to this rule, for its substance may be cut and operated on in various ways without causing the slightest pain. It is evident, therefore, that in a large proportion of the actually painful experiments performed in physiological laboratories the pain must be of the briefest duration, since it is almost wholly confined to the preliminary incision. It must also be borne in mind that a large class of experiments consists in the introduction of drugs under the skin, an operation about as painful as vaccination or as a subcutaneous injection of morphia. Bearing these facts in mind we are well prepared to accept Professor Yeo's estimate, and that of the twenty-five per cent. of actually painful experiments, twenty per cent. are about as painful as vaccination, four per cent. about as painful as the healing of a wound, and one per cent. as painful as an ordinary surgical operation performed without anesthetics.

I have thus sought to set before you the material for forming a judgment with regard to the amount of animal suffering which the practice of experimental physiology involves. It remains for me now to speak of the value of the discoveries thus made or, in other words, to present to you briefly the evidence of the debt owed by the practising physician of the present day to the physiologists of the past. We shall then be in a position to answer the question whether on the whole "vivisection pays." To enumerate all the discoveries that have been made in physiology by means of experiments on animals would be utterly impossible within the limits of this discourse, for there is hardly a single organ of the human body whose functions have not been investigated and explained in this way. It will suffice at this time to call your attention to a few of the more important physiological discoveries which form the groundwork of our knowledge of the human body, and to ask you to imagine, if you can, what would be the condition of the healing art if these discoveries had never been made.

To begin with, let us consider the circulation of the blood, a discovery bearing the same relation to medicine that the law of gravitation bears to physics. It is well known that the ancients believed the arteries, as their name implies, to be tubes containing air. When Galen, in the second century of our era, studied the arteries on living animals, the fact that they carry blood was, of course, apparent. The circulation of the blood was, however, far from being made out. In fact, it was not till the beginning of the seventeenth century that Harvey, gathering up the learning of the time, contributed by the great Italian teachers Vesalius, Eustachius, Fallopius, Fabricius of Aquapendente, and others, and making important additions of his own (as he himself says) "by frequently looking into many and various living animals" was finally able to promulgate the true theory of the circulation of the blood. Since the time of Harvey our knowledge of the conditions under which the blood circulates has been greatly extended, and always by means of experiments upon living animals. The pressure which the blood exerts upon the walls of the vessels in different parts of its course has been carefully measured. The fact that its white globules can pass through the vascular walls into the tissues outside has been clearly demonstrated, and forms, in fact, the basis of the modern theory of inflammation. The influence of the nervous system in controlling the size of the channels through which the blood circulates, thus regulating the nutrition of the tissues, the activity of the organs and the distribution of heat, has been studied by a host of observers, and is, indeed, one of the most fruitful fields of modern physiological research. It is difficult to imagine what the practice of medicine would be without this knowledge which has been wholly obtained by experiments on living animals and which is now the common property of educated physicians. It has, indeed, been very pertinently asked, "How will those earnest antivivisectionists, who like Miss Cobbe, 'prefer to die sooner than profit by such foul rites' provide themselves with a medical attendant warranted ignorant of the circulation of the blood?"

The direct benefits received from animal experimentation are perhaps more obvious in surgery than in the other departments of medicine. The proper mode of applying ligatures to arteries and the antiseptic treatment of wounds have reached their present stage of perfection largely through experiments on the lower animals. To give you a vivid idea of the privileges which we are now enjoying I will ask you to listen to Ambrose Paré's description of an amputation as performed in his time: "I observed my masters, whose method I intended to follow, who thought themselves singularly well appointed to stanch a flux of blood when they were furnished with various store of hot irons and caustic medicines, which they would use to the dismembered part, now one, then another, as they themselves thought meet, which thing cannot be spoken or but thought upon without great horror, much less acted. For this kind of remedy could not but bring great and tormenting pain to the patient, seeing such fresh wounds made in the quick and sound flesh are endured with exquisite sense. . . . And verily of such as were burnt, the third part scarce ever recovered, and that with much ado, for that combust wounds with difficulty come to cicatrization; for by this burning are caused cruel pains, whence a fever, convulsion, and ofttimes other accidents worse than these. Add hereunto, that when the eschar fell away, ofttimes a new hemorrhage ensued for stanching whereof they were forced to use other caustic and burning instruments. Through which occasion the bones were laid bare, whence many were forced, for the remainder of their wretched life, to carry about an ulcer on that part which was dismembered; which also took away the opportunity of fitting or putting to an artificial leg or arm, instead of that which was taken off."

Let us now contrast this ghastly picture with the methods of a modern amputation. The patient is first made unconscious by the use of ether or chloroform. The blood-vessels of the limbs are then emptied by means of an elastic bandage. Hardly a drop of blood is shed in the amputation itself, the divided arteries are firmly tied, and the wound, treated antiseptically, heals with little or no pain. At every step in the process which has led to this brilliant result experiment has been the guide. Various technical details of the method remain still to be worked out. It is this beneficent work which antivivisectionists seek to abolish.

I will allude to but one other benefit conferred upon suffering humanity by scientific experiments in-

volving the sacrifice of animal life. The therapeutic use of antitoxin, though still in its infancy, shows by the unimpeachable records of hospital practice that the physician has now within his grasp the means of successfully treating one of our most dreaded diseases. The anxiety, almost amounting to despair, with which a physician formerly approached a serious case of diphtheria has given place to a feeling of well-grounded hope of a favorable result. Who can estimate the burden of terror and distress thus removed from the anxious watchers by the bedside, and who will dare to say that the boon has been dearly purchased by the lives of some thousands of guinea-pigs?

Let us now briefly review the points over which we have already passed. We have seen, in the first place, that pain is a purely subjective phenomenon, the sensibility to which differs very much in different individuals, and is in the lower animals reduced apparently much below that of the least sensitive human beings, and that, moreover, the external signs of suffering are apt to be misleading unless the conditions under which these signs are made are well understood, a knowledge which can be acquired only by careful physiological study. We have seen, in the second place, that pain is only relatively an evil, that we submit to it ourselves and subject others to it for the sake of subsequent advantages which we consider sufficiently important. Thirdly, we have seen that our relations to animals are such that there is no well recognized objection to our causing them very great suffering for the sake of very slight benefits to ourselves. In this matter there is, of course, great room for improvement. The practical question always is "How much suffering may we inflict on an animal for the sake of how little benefit to ourselves?" In the progress of civilization there is a constant tendency to draw the line more and more in favor of the animal; but when we remember how much opposition was, within a few years, arrayed in this State against the passage of a law to abolish pigeon-shooting, we cannot flatter ourselves that we have, as yet, reached any very advanced humanitarian standpoint. It is certainly no very extravagant concession to the rights of animals to enact that they shall not be set up as living targets at a shooting-match when glass balls thrown into the air will answer the same purpose. In forming and fostering a public opinion which demands a greater consideration for the brute creation the societies for the prevention of cruelty to animals have played an important part, and their work would doubtless be still more effective were they in the habit of making more frequent applications of the results of physiological research to the problems of animal life. By the efforts of these societies and by the general growth of humane sentiments in the community, we may expect that a larger and larger prospective benefit will be demanded as a justification for the infliction of pain upon animals. To this raising of the requirements of humanity physiologists will be certain to offer no objection, provided the same rule is applied to all occupations involving pain to animals; for it is evident, I trust, from what has been said that a standard so high as to be practically inapplicable to the daily affairs of life will still leave a wide margin for the carrying on of physiological research. A questionable practice cannot, of course, be justified by demonstrating that another still less justifiable practice exists; but it may be fairly urged that while practices are permitted which cause great suffering to animals with only incidental benefits to mankind, "it is irrational folly," to quote a writer in *Nature*, "to waste the energy of humanitarian feeling in a warfare against the only kind of pain-giving practice which is directed toward the mitigation of pain, and which has already been successful in this, its object, to a degree out of all proportion to the pain inflicted."

Enough has been said, I trust, to demonstrate the expediency of permitting physiological research to go on unchecked, and even of encouraging it in every possible way, as the only legitimate basis of scientific medicine. Before leaving the subject, however, it is well to notice that, whatever restrictions be imposed on the physiologist working in his laboratory, the advancement of medicine by experiment will be certain to go on. Agitation cannot check it. Legislation cannot prevent it. Once admit, what no one thinks of disputing, that physiological phenomena are chemical or physical in their character, and the position of physiology among the experimental sciences is a matter of necessity. All that legal enactments can do is to determine to some extent who shall be the experimenters and who the victims of the experiments. Shall practising physicians grope blinding in search of methods of treatment when chance brings disease under their observation, or shall men of science, systematically studying the nature and results of morbid processes in animals, point out to the practitioner the path to be followed to render innocuous the contagion of our most dreaded diseases? In illustration of this point permit me to quote a few lines from Dr. John Simon's address on State Medicine: "The experiments which give us our teaching with regard to the causes of disease are of two sorts; on the one hand we have the carefully pre-arranged and comparatively few experiments which are done by us in our pathological laboratories, and for the most part on other animals than man; on the other hand, we have the experiments which accident does for us, and above all, the incalculably large amount of crude experiment which is popularly done by man on man under our present ordinary conditions of social life, and which gives us its results for our interpretation. . . . Let me illustrate my argument by showing you the two processes at work in identical provinces of subject-matter. What are the classical experiments to which we chiefly refer when we think of guarding against the dangers of Asiatic cholera? On the one side there are the well-known scientific infection experiments of Professor Thiersch performed on a certain number of mice. On the other hand, there are the equally well-known popular experiments which during our two cholera epidemics of 1848–49 and 1853–54 were performed on half a million of human beings, dwelling in the southern districts of London, by certain commercial companies which supplied those districts with water. Both the professor and the water-companies gave us valuable experimental teaching as to the manner in which cholera is spread. . . . Now, assuming for the moment that man and brute are of exactly equal value, I would submit that, when the life of either man or brute is to be made merely instrumental to the establishment of a scientific truth, the use of the life should be economical. Let me, in that point of view, invite you to compare, or rather to contrast with one another, those two sorts of experiments from which we have to get our knowledge of the causes of disease. The commercial experiments which illustrated the dangerousness of

sewage-polluted water-supplies cost many thousands of human lives; the scientific experiments which, with infinitely more exactitude, justified a presumption of dangerousness cost the lives of fourteen mice."

We see then in one way or another experiment must form the basis on which medical science is to be built up. The question for us to decide is, "Shall these experiments be few, carefully planned, conclusive, economical of animal life, or shall they be numerous, accidental, vague and wasteful of human life?" I think in settling this question we may safely take for our guide the words of Him who said, "Ye are of more value than many sparrows."

Original Articles.

PHOTOGRAPHY OF THE HUMAN STOMACH BY THE RÖNTGEN METHOD, A SUGGESTION.

BY JOHN C. HEMMETER, M.D., PH.D., BALTIMORE, MD.

In the *Deutsche Medizinische Wochenschrift*, No. 13, March 26, 1896, Dr. Wolf Becker, of Berlin, describes a method for photographing the hollow organs of the animal body by the Röntgen process. In his work on "A New Kind of Rays," Röntgen, after stating that the various metals are permeable to the rays to different degrees, says that the salts of the metals, in a solid form or in solutions, can be arranged in a similar manner to the metals, with regard to their permeability.

This property of solutions not to allow the Röntgen rays to penetrate, he utilized to photograph the stomach and a loop of intestine of a guinea-pig by distending both with liquor plumbi subacetici of the German pharmacopœia. To fill the organs mentioned Becker did a laparotomy, tied the stomach both at the cardia and pylorus and the intestinal loop at both ends, and then injected the solution of subacetate of lead by means of a Pravaz syringe. In doing so he tore the gastric walls, which had to be sewed up again, but could not be repaired so tightly as to prevent leakage. The possibility of injecting the subacetate through the mouth and œsophagus did not suggest itself to him, it seems. A Rumkorff inductor producing a spark fifteen centimetres long was used, and the distance of the lowest pole of the Hittorf (Geissler) tube from the highest point of the object was twenty-three centimetres. The time of exposure was thirty-five minutes.

In the photograph, the only parts of the abdominal contents that are visible are the parts that contain the lead-acetate solution. It cannot be claimed, however, that the outlines of the stomach and intestinal loop are at all well defined, which is explained, perhaps, by the circumstance that the solution leaked out into the abdominal cavity.

To obtain a photograph of the human stomach a solution is necessary having two properties: (1) it must not injure the stomach of the subject to be photographed; (2) it must be impenetrable to the Röntgen rays. Then it will be important to observe in what dilution these solutions may yet refuse penetration to these rays of light.

In No. 18, April 30, 1896, of the same journal, Dr. Carl Wegele, of Königsborn, Westphalia, in commenting upon Becker's experiment, suggests the introduction of his spiral electrode into the stomach in such a manner that it should come to lie along the greater curvature of the stomach. A small coin is suggested to be placed over the umbilicus. Both the metal of the electrode and the coin would show in the photograph and thus some idea of the location of the stomach might be obtained. This would, however, give no impression of the size of the organ as the metal of the electrode would in favorable experiments map out the greater curvature only. Although the duration of exposure for the Röntgen method has been much shortened by the improved technique of the physical laboratory of the University of Jena, the plan to determine the location and size of the stomach by the Röntgen photography can hardly be considered anything but circuitous.

A rapid and most reliable method of determining the location of the stomach is by Einhorn's electrodiaphany; and its capacity and also its location can be readily ascertained by the use of my intra-gastric, deglutable, elastic-rubber bag.[1]

The liquor plumbi subacetatis used by Dr. W. Becker is not a solution of simple plumbic acetate, but contains also oxide of lead in the proportion of three of the former to one of the latter; besides being poisonous, it acts upon mucous membranes like a corrosive. I do not consider the use of the Röntgen method, on account of its complexity and long duration of exposure, as practical for determining the size and location of the stomach; if, however, one wishes to experiment with it to ascertain whether there is any value in it, I would suggest that the solution of plumbic acetate be injected into my intra-gastric, stomach-shaped rubber bag. These bags as made by Tieman & Co., of New York, for me, can be made strong enough to hold sufficient of the solution to distend the adult stomach, and at the same time can be swallowed easily or pushed down, after they are folded over a thin esophageal tube. When the bag which has exactly the shape of the stomach, has reached the cavity of the organ, the plumbic acetate solution can be slowly filled in through the mouth by means of the esophageal tube until the bag is distended far enough to closely apply itself to the gastric walls. The umbilicus might be marked by a coin as suggested by Wegele. A photograph taken in this manner would give, not only a part of the stomach, but the entire organ and show its location and size. After the exposure the solution of plumbic acetate would have to be removed by aspiration, for which a stomach-pump would be useful for speedy evacuation.

Recently a method for intubating the duodenum has been described by the author,[2] which makes it conceivable that elastic bags may be introduced into and distended in the duodenum for diagnostic purposes and also for similar experiments as those suggested in this report. (See also article on "Intubation des Duodenum," in Boas's Archiv für verdauungs Krankheiten, Band ii, Heft 1, by the author.)

ADDENDUM.

Plumbic acetate precipitates albumins, proteids, albuminoids. It is essential, therefore, to have the India-rubber, intra-gastric bag made of pure gutta-percha. Recently I made a number of experiments in the biological laboratory of the Johns Hopkins

[1] Hemmeter: Motor-functions of the Human Stomach, etc., New York Medical Journal, June 22, 1895, p. 771.

[2] Hemmeter: Intubation of the Duodenum, Johns Hopkins Hospital Bulletin, April, 1896.