

## **On animal vaccination / by Henry Austin Martin.**

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ON

ANIMAL VACCINATION.

BY

HENRY AUSTIN MARTIN, M.D.,

MEMBER AND CHAIRMAN OF COMMITTEE ON ANIMAL VACCINATION OF AMERICAN  
MEDICAL ASSOCIATION ; BVT. LT. COL. AND LATE SURGEON U. S. VOLS.

WITH ILLUSTRATIONS.

Et ce champ ne se peut tellement moissonner  
Que les derniers venus n'y trouvent à glaner.

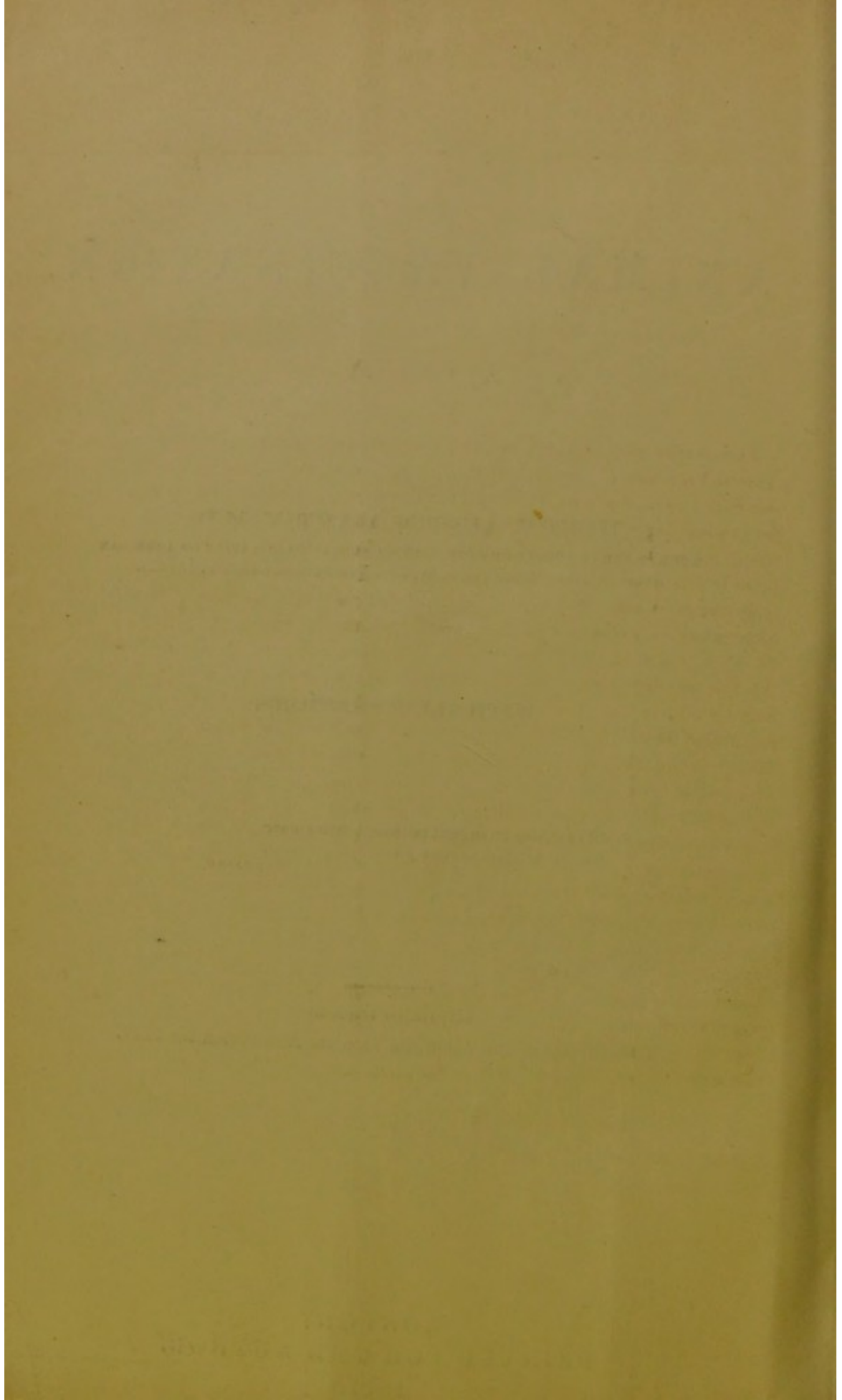
LA FONTAINE.

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1877.



## APOLOGY.

THE reader will probably observe that the two illustrations to my report on Animal Vaccination (particularly the smaller one) hardly merit the commendatory mention I have made of them. That commendation was entirely applicable to the original engraving and lithograph, and the "trial proofs," which were first made, led me to feel perfect confidence that the excellence of the originals would be well preserved in the heliotype copies. I can only say that I have been utterly disappointed. Not a single copy of the one-page illustration even distantly approaches the excellence of the "proof" which was given as a specimen of what the work would be. The larger print is better, but many of the copies of even this are very inferior. This unsatisfactory result has been from no fault of mine, and it would be unprofitable to enter into details of the reasons for it. I sincerely regret that these illustrations are not what I hoped and had a right to expect. Although the smaller one gives no idea whatever of the beauty of the original, the strong dark lines and coarser parts of the drawing of which are alone reproduced, it has still some value as an illustration of what I consider an important point, and I have reluctantly directed its insertion, as I have not another day to devote to a continuance of my effort for a better execution of the work, and as my dilemma is either to do this or leave out entirely an illustration particularly necessary to a clear understanding of the text. The larger illustration is, perhaps, as good as I had a right to expect in the present apparently *very* imperfect development of the "heliotype process" in this country. If carefully examined, the reader will see in it the very remarkable difference, after the tenth day, of the progress and "scabbing" of the vesicles induced by virus of a very few removes from the cow, and by that of very long humanization. In the original, however, that wide difference is exhibited with very much greater clearness.

H. A. MARTIN.

BOSTON, December 15th, 1877.



### C O R R I G E N D A .

Page 3—18th line from top, "these results" instead of "the results."

Page 4—3d and 2d lines from foot of page should read "(2) Retro-Vaccination or the vaccination of animals with humanized lymph as a *supposed* means of restoring the vigor of enfeebled and purifying contaminated vaccine virus."

Page 4—17th line from foot of page, "defeat" instead of "defects."

Page 8—18th line from foot of page insert "and" after "Jenner."

Page 14—13th line from top of page read after "state" "that particular experiment."

Page 15—11th line from top, "method" instead of "methods."

Page 19—16th line from foot of page, "scores" instead of "cases."

Page 24—1st line of note, "one-fourth" instead of "one-half."

Page 25—16th line from top of page, "each" instead of "such."

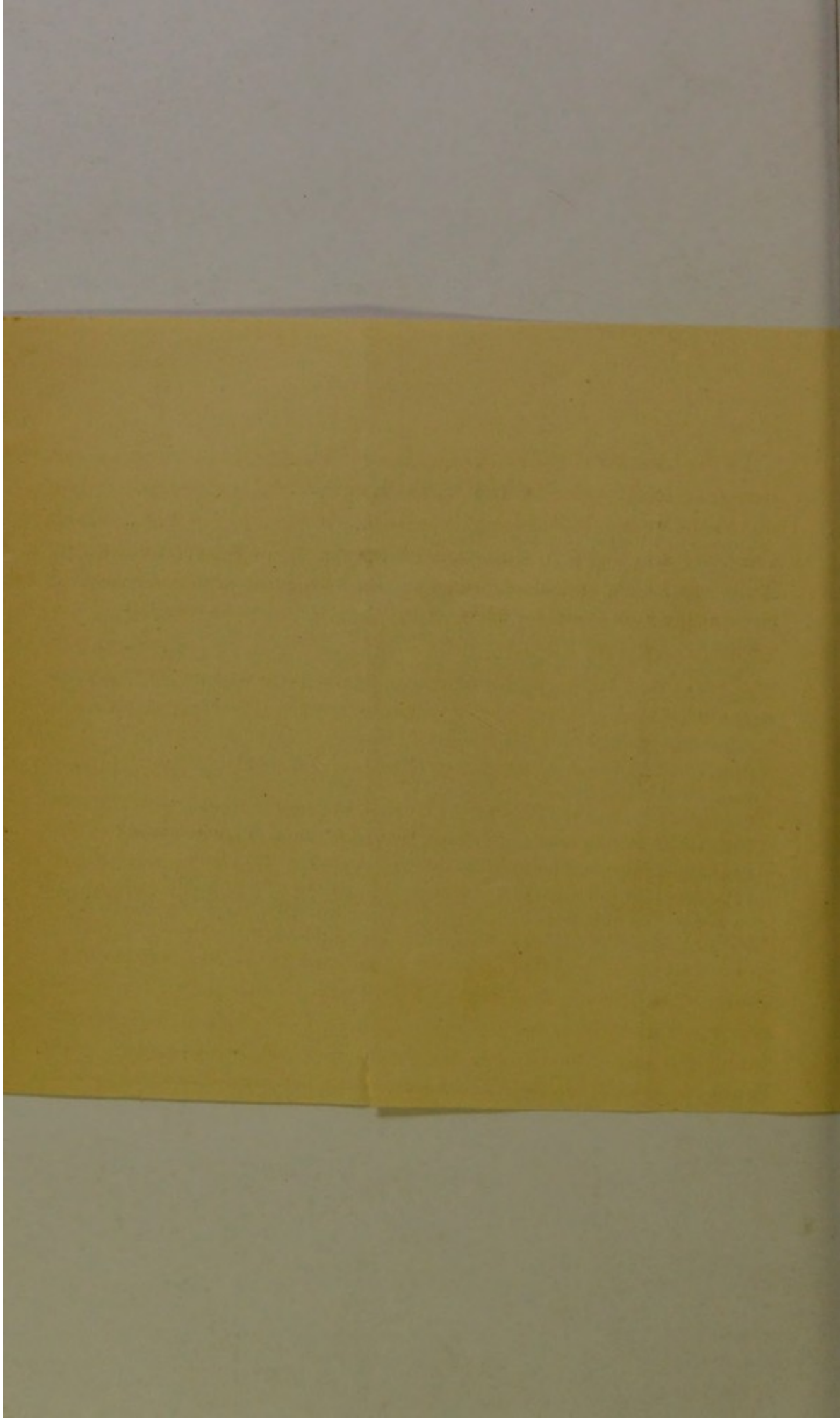
Page 29—24th line from foot of page, "*vaccinee*" instead of "*vaccinia*."

Page 30—12th line from top, "has often" instead of "is often."

Page 30—15th line from top, "so useful" instead of "as useful."

Page 33—17th line from foot of page, "one-quarter" instead of "one-half."

Page 44—5th line from top, "ever" instead of "even."



## REPORT ON ANIMAL VACCINATION.

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IN the formation of the committee of this Association, appointed last year to investigate and report upon animal vaccination, three members were selected, each residing in a city far distant from the others. Consultation and co-operation were impracticable. This report is, therefore, entirely the work of the chairman of the committee; and as he has not been able, notwithstanding an effort to that end, to meet either or both the remaining members and submit it to them, he offers it as his personal report, assuming entire and undivided responsibility for all its statements.

The object of this report is the consideration of animal vaccination, and to lay before you, and, through you, the medical profession and people of the United States, a clear definition of that innovation in practice, and its claims, if any, to be adopted, to the entire or partial exclusion of the Jennerian or arm-to-arm system.

In this country, beyond most others, in the total absence of all State institutions for distribution of virus and the diffusion, by reports and otherwise, of information respecting it, it is important that societies representing the medical profession in each State, and, still more, an Association, the only representative body of the entire regular medical profession of the whole nation, should from time to time pronounce its judgment on the varying problems which the lapse of time may develop in regard to a subject of such general and paramount interest and importance as vaccination.

The innovation in practice, to which the term animal or bovine vaccination has been given, seems by the writer to be precisely one of the things in regard to which the voice of this



Association should be heard, either in approval or condemnation, with no uncertain sound.

Vaccination stands alone. The terrible disease which it is its purpose to avert stands also alone and quite unapproached among the many plagues with which our poor humanity is beset. The whole subject of vaccination is so important, the ends it proposes to accomplish are so incomparably beyond all others essential to the safety and protection of the community, that no change in its practice should be made without the most careful consideration and for very weighty and solid reasons. The present report will most earnestly suggest and urge an entire change and reformation in the method by which vaccine virus is propagated. It will propose and recommend that all vaccinations shall be made with virus obtained from animals of the bovine species—a method entirely novel, and which was practically unknown to the general medical profession before the year 1866. Such a change is, of course, the most pregnant for possible good or evil that can be suggested.

For nearly the Horatian term of seven years true animal or bovine vaccination has been before the profession of the United States. Circumstances, prominent among which have been the occurrence of a very wide-spread epidemic of variola of peculiar virulence, the independent intelligence and culture of the people, and the freedom from senseless prejudice of the American profession of all schools, have contributed to make this the country in which the system has been most fully tested;—the only one in which, with the brilliant exception of Belgium, it has had anything like a fair and impartial trial. It cannot be said that the experiment has not been thoroughly made in America. Seven years, during most of which variolous disease has prevailed in some part of the country with very peculiar severity, is an ample period for any earnest and honest inquirer to determine every possible question, except the single one of whether the endurance of protective efficacy of vaccination with the new virus surpasses that so long practised; a question that time, which, as Bacon saith, and not authority, is the mother of truth, can alone determine. One thing remains to be done, for the medical profession of America, through this its representative body, to announce its verdict on one of the most important questions which has ever been brought or which can ever come before it. Shall the method of true animal vaccination receive the ap-

proval of the American Medical Association and its warm commendation to the consideration and adoption of the medical profession and the people everywhere? or shall it, so far as this Association can do it, be committed to that vast limbo whither have passed already so many methods and systems and theories and novelties in medicine?

“Of all things vain, and all who in vain things  
Build their fond hope of glory or lasting fame.”

One word more of preface. None can be more sensible of the many defects of this report than its author. With extreme hesitation has he concluded to present it for acceptance. He alone can most fully estimate the vast extent and difficulty of the task he has assumed if performed as it should be. He is well aware that his work is very far indeed from such a standard; but, imperfect and unsatisfactory to himself as it is, he considers its presentation now a matter of duty. With all its defects, it contains some of the results of a life's devotion to the study and practice of vaccination. Some of the results are, so far as the author knows, original; many of them are thought to be of very great practical importance; and although by another year a much more perfect and finished report might be prepared, one that would do far more honor to the author, it would only do so by presenting with more elaboration and literary finish precisely the same facts and opinions which are now offered without such advantages. If the reader agrees with the author as to the great importance of the matter, he will, perhaps, be inclined to be lenient in criticism of the manner of the report.

The discussion of the topic of animal vaccination involves, if fully done, a consideration of the entire vast subject of vaccination. The writer might very easily have written a limited and merely technical paper on the vaccination of animals. Such a report was never contemplated by himself, nor, as he thinks, expected or wished by this Association. The question of paramount importance is, Whether the virus obtained by the inoculation of bovine animals with the virus of original cowpox induces the development of *vaccinia* of greater perfection, and, therefore, of probably more protective efficacy, than that obtained by the transmission of the same disease on a series of human subjects? It is this question which so nearly and deeply

concerns and interests not only every physician, but every human being. If the writer of this report even partly and imperfectly yet truly answers this great question, he will be well satisfied in having done a service to humanity by no means insignificant or unimportant; a service also which he feels confident will not always be unappreciated in having not only introduced animal vaccination into America, but in constantly and laboriously striving for its vindication and extension.

### REPORT.

Without further preface, let us consider the questions on the determination of which must depend the acceptance or rejection of the method of true animal vaccination. These questions may be included under four heads: (1) What is true animal vaccination? (2) What is Jennerian vaccination? (3) What are the advantages and defects of the Jennerian system, and is the assertion of the latter founded on reason and experience? (4) What are the advantages and defects of true animal vaccination? and how well founded are the assertions made by its advocates, that by its honest and full acceptance, and thus only, can the defects—which time and observation, a million times repeated, have demonstrated in vaccination as so long practised—be triumphantly remedied, the greatest boon ever granted to humanity restored, and, through the defects of the “Jennerian system,” justice and due honor at last done to the memory of Edward Jenner?

QUESTION FIRST.—What is true animal vaccination?

It is very necessary that it should be exactly understood what is meant by the various terms animal vaccination, bovine vaccination, heifer vaccination, retro vaccination, variolo vaccination, equination, etc. etc. A very great deal of misapprehension exists on this point, and many, indeed most, of the positive and unfavorable criticisms of the new vaccination have been based upon a supposition that it is something which it is not.

There are four chief methods to which the term can and has been applied: (1) Vaccination casually or intentionally from the original spontaneously occurring disease in the milch cow. (2) Retro-vaccination with virus obtained from the vaccine disease in the human subject. (3) From vesicles, said to be vaccine vesicles, obtained by variolation of kine, or the inoculation of

bovine animals with the virus of smallpox. (4) The method of true animal vaccination, or the inoculation of a bovine animal with the virus of original spontaneous cowpox; from this another, and so on in continuous and endless series as a source of vaccine virus. During the first ten years of vaccination an universal *furor* of experiment prevailed; a vast number and variety of animals were vaccinated. Similar experiments have since that time been occasionally repeated. Not only mammals, from the elephant to the mouse, but also birds and reptiles were thus experimented upon. It was found that the disease could be reproduced in the horse, the goat, the sheep, the pig, and, I believe, some other animals; and the use of virus from these gave names to other varieties of vaccination, as equination, ovination, and possibly caprination and porcination; but all this has only a certain historical interest, and need not delay us. These four varieties of animal vaccination include all, the consideration of which is of any importance whatever for our investigation.

(1) CASUAL OR INTENTIONAL INOCULATION FROM ANIMALS AFFECTED WITH ORIGINAL COWPOX.—This must, of course, be included among the varieties of animal vaccination; but when it is stated (notwithstanding certain fictions in early American vaccine literature) that no *perfectly authenticated* case of *true* cowpox has ever been known in America, it will be evident that it is of little practical importance to American physicians. The writer for many years offered a considerable reward for information of any case which should prove to be true cowpox, and, at a very considerable expenditure of effort and money, often traveling great distances, has at various times visited over twenty dairies and stables in which cowpox was reported to exist. He has never as yet, however, been rewarded by discovering what he so eagerly sought. On two occasions he found animals suffering from a very common bovine eruption or pock, described by Hering, Ceely, and others, from the pustules of which large quantities of fluid had been collected on many hundred quill slips. In three instances, in which, from the advanced state of the eruption, there was possibility of doubt, he collected crusts, and carefully used them in inoculation of young animals without any result. He has, on five different occasions, had crusts of so-called cowpox sent to him from California—in the vast herds of which State cowpox is said (by not very competent observers,

however) to prevail at certain seasons—and from Wisconsin. These were all employed in inoculation of animals without effect. One other gentleman, the writer knows of, who firmly believes in American cowpox, and who has spent much time and labor in an as yet vain effort to find it. Several other less persistent seekers have thus far reaped only disappointment. In Continental Europe, on the authority of Bousquet, not a single *properly authenticated* case of spontaneous cowpox was reported for thirty years previous to 1836, possibly because in the perfect and unquestioning faith in the Jennerian virus, which continued during the life of its great advocate, such cases were not much cared for or looked after. However this may be, the occurrence of cowpox is very variable; at times it widely prevails in a great many different dairies, and again no case will be heard of for many years. If it should be found, as now seems probable, that cowpox, transmitted on a series of bovine animals, does not tend at all to deteriorate or to essentially change in any way from a perfect standard of excellence, the ascertainment of the existence of cases of spontaneous cowpox will be of little consequence or value. If, on the contrary, cowpox so transmitted tends at all to deteriorate, such cases will, of course, be of value as a means of renewing the “stock” or “strain.”

Before leaving this part of our subject, we may allude to the great intensity of the phenomena induced by the inoculation of original cowpox virus on the human subject. This has been noticed by all the old writers on vaccination, as well as by Hering, Ceely, and other modern investigators. There is no doubt of this, and it is of great importance to us. The undue violence of the *vaccinia*, induced not only by original cowpox virus, but the earlier human removes from it, undoubtedly strongly conduced to the ready acceptance and continuance of the Jennerian method as a means of avoiding them. The tradition of such violence in the casual cases in the milkers, the observation of which first led to Jenner's discovery, has, without doubt, had a great effect in dissuading many prudent and careful practitioners hitherto from adopting or favorably regarding the transmission of so violent a disease on the species in which it was first observed as a source of vaccine supply. When we come to consider the asserted objections to the heifer-transmitted cowpox virus, this point will be carefully considered. We wish

here to admit and record the perfectly ascertained fact that inoculation with the virus of the original disease induces phenomena of an undesirable intensity, extremely liable to be followed by troublesome and even severe ulceration. If original cowpox virus were to be obtained, this alone would constitute a complete objection to its employment, unless we were destitute of all other safe and effective means of insuring protection against variolous contagion. It may, on all accounts, be admitted that original cowpox virus may be dismissed from further consideration as a source of material for vaccination, except, perhaps, as an occasional means of renewing enfeebled and deteriorated "stocks" of humanized virus, although we think it can already be demonstrated that, in successive vaccinations of bovine animals from a perfect original "stock," there is no real tendency to deterioration or essential change.

(2) RETRO-VACCINATION OR THE INOCULATION OF BOVINE OR OTHER ANIMALS WITH THE VIRUS FROM THE VACCINE DISEASE IN THE HUMAN SUBJECTS.—This was practised, experimentally, immediately after Jenner's announcement, and repeated then and since by a great many students of vaccination. A student of Waterhouse did it in 1801, and a great many similar observations are recorded in the first volume (1800-1803) of the reports to the famous Comité-central de Vaccine, one of the most important and interesting volumes in the whole range of vaccine literature. Sacco, also, in his admirable work, *Robt. Ceely*, in 1841, and a great many others, have given us elaborate and accurate accounts and delineations of this form of animal *vaccinia*. It has, rather recently, and more than once, been done by zealous *savans* who, succeeding in the experiment, have supposed that they had made a great discovery and eagerly communicated their claims to medical societies and other local coteries who, in one instance at any rate, seems to have received and recorded the claim in good faith as an evidence of the scientific energy and success of one of its members. About twenty years ago the writer of this paper repeated the experiment several times with perfect success so far as inducing *vaccinia* in the heifer. He tested the virus thus obtained with results which will be elsewhere stated. Very extensive experiments have lately been made in France, in this as well as all the other varieties of experimentation in animal vaccination, by a committee of which M. Chauveau was chairman,

the report of which is one of the classics of the literature of animal vaccination. It is hardly necessary to describe the phenomena of *retro-vaccinia* in the animal. Full description and exquisite colored drawings of retro-vaccinia may be found in the rare and beautiful work of Robert Ceely. What is of importance for our purpose is the fact that at various times, and particularly from 1828 to 1838, retro-vaccination has been suggested and practised with the hope and sanguine expectation that, in this way, the possible contaminations and very evident deterioration of long humanized virus might be remedied and repaired. The method has, since the latter date, been continued to a greater or less degree in certain of the German States, particularly Wurtemberg and Bavaria; also in Naples, and other parts of Italy. In Naples there is no doubt that since very early in the century this method has been perhaps the only one for obtaining material for vaccination. This practice of retro-vaccination in Naples will be considered in another part of this report, viz., that which treats particularly of true animal vaccination as, from the diffusion and development of the Neapolitan method arose directly that which we advocate. To a certain extent, it is not easy or important to ascertain exactly how great retro-vaccination and perhaps other forms of animal vaccination have been practised in most of the States of Germany, since the panic which arose shortly after the death of Jenner, was due to a strong conviction of the extreme degeneration of the Jennerian virus, and a dreadful apprehension that the great prophylactic was in imminent danger of perdition. The fact that for over twenty-five years before the year 1831, not more than two or three really and absolutely authentic cases of original cowpox had been observed in Europe, that the Jennerian virus had changed to such an extent that it was considered necessary to greatly increase the number of places of insertion, sometimes to the number of even fifty or sixty, and very generally to that of eighteen or twenty-four and upwards, even then not inducing the decided febrile reaction which it was the object of this multilocular vaccination to induce, and which had been always noticed by Jenner in his vaccinations with early removes from the cow as concomitant with the development of the areola about the single vesicle to which he at first restricted himself and his disciples. This febrile reaction Jenner always maintained to be, as the only perfect proof of constitutional affection, *absolutely essential* to the perfec-

tion of the prophylaxis. Without it he pronounced a vaccination merely local and quite or nearly without value. At this time retro-vaccination occupied the anxious attention of the profession and was most extensively and practically tested. Some few sanguine and visionary people spoke and wrote, of course, as if by this method all difficulties could be and indeed had been removed, impurities purged away and pristine vigor recovered. Such, however, was not the verdict of the only class of observers whose opinion is worth knowing. Men like Ceely, anxious as any that retro-vaccination should prove to be all that was wished, state their reluctant conviction that long humanized virus gains nothing in strength or even purity by passing through the bovine system, and indeed loses very markedly, after the transit, the quality of "taking" or readily affecting the human system, which quality, however, is recovered in a single human remove. This was all most thoroughly demonstrated, and, therefore, retro-vaccination need not much longer detain us. Certain theoretical and not very well informed physicians still, however, continue to speak and write of this method of remedying defects in virus. In certain parts of Germany, Bavaria for instance, once a year humanized virus is employed to vaccinate a milch cow; virus from which is issued by the State to the physicians of the kingdom to recuperate and renew their "stock" of virus. There are, of course, many things of scientific interest in the study of retro-vaccination, but as a source of vaccine supply, our only subject of inquiry, we may dismiss it here.

(3) VARIOLATION OF KINE, OR INOCULATION OF BOVINE ANIMALS WITH VARIOLOUS VIRUS, WITH THE VIEW OF THUS INDUCING COWPOX, VIRUS FROM THE VESICLES OF WHICH MAY BE USED FOR VACCINATION, TO RESTORE THE VIGOR OF VACCINE STOCKS.—An immense amount of misapprehension exists in regard to this method. Jenner, in his very first publication, indicated by the name he gave to the cowpox (VARIOLÆ VACCINÆ), and otherwise, his belief and conviction that *variola* in man, the *grease* in horses, and the *variolæ vaccinæ* in cows, were all manifestations of a single cause. Accumulated experience, some of which, and the most conclusive is quite recent, seems very decidedly to confirm this wonderful and apparently intuitive guess of the worthiest of the disciples of Hunter. As a necessary consequence of this announcement, experiments were made to



artificially induce cowpox by variolous inoculation of kine. During the first five years of vaccination, this experiment was probably repeated hundreds of times, and from that date to this it has been a favorite experiment with ardent investigators not satisfied with the infinitely repeated results of the past. Failure to accomplish the desired object has been the rule in all but a very few of these experiments. On the fingers of one hand may be counted the experimenters who even claim success, and these claims are by no means beyond doubt and criticism. Notwithstanding this there is a very general impression that animal vaccination consists in the practice of bovine variolation and the use of virus thus obtained. It cannot be denied that this experiment still possesses great scientific interest, but the elements of error are so numerous that unless observations upon it shall be made by men of consummate knowledge of all the details, not only of bovine and human vaccination, but of all the details of *variola* and of variolous inoculation also, they will be of little or no value. It must also be borne in mind by those who attempt to succeed where so many have failed, that more than once or twice virus, issued widely by jubilant *savans*, has been employed, and the result has been a wide diffusion of smallpox. This whole subject possesses very great interest, and some events have transpired during the past few years which render a full examination into the propriety and safety of variolo-vaccination very necessary. Notwithstanding this, the scope of this paper does not allow of such an investigation here. Enough for us that the variolation of kine is not to be looked to at present, nor probably in the future, as a safe and desirable means of supplying vaccine virus. The writer would here state his conviction that, in some mysterious manner, nature elaborates *vaccinia* from *variola* in the system of the milch cow, but that man can, with no certainty or safety, repeat her process at will, nor does nature herself accomplish it always with equal success.

(4) TRUE ANIMAL OR BOVINE VACCINATION, OR HEIFER-TRANSMITTED-COWPOX VACCINATION DEFINITION.—The inoculation of a young selected animal of the bovine species, from an original spontaneous case of cowpox, from this others, and so on in continuous and endless series as a source and the only source of virus to be used for the protection of the human race from variolous disease. This definition may be considered unnecessa-

rily elaborate and precise, but there has been so much and such singular error in regard to the subject and in quarters where error ought to be little expected, that I think it best to err on the side of redundant definition rather than on that of one too meagre and deficient. To this method alone, if we except the casual or intentional inoculation from the original disease in the milch-cow, is the term animal vaccination properly applicable. This source of virus is purely and exclusively animal. The term heifer-transmitted-cowpox virus expresses exactly the method of obtaining the virus, its source, and the result. This method was inaugurated in America in September, 1870, and the fact that it was so was announced to the profession in the *Boston Medical and Surgical Journal* for Oct. 20 of that year. During the months of July and August three vaccinations were made, one of a calf and two of infants, the first and one of the latter successfully, with four points which were sent me in letters on two occasions, merely as specimens and without the slightest notion that they would reach me in an efficient state. I had in this way obtained an excellent opportunity to observe peculiarities of animal vaccination both in the animal and the human subject before the return of my special agent from Paris with ample supplies of animal virus in tubes and on ivory points and squares of glass, collected and sealed by Professor Depaul in his presence, autograph directions from the same distinguished *savant*, and a full collection of pamphlets and other publications by Professor Depaul and others. My agent returned to Boston on the 23d of September, 1870. I had secured the use of a farm on which was a herd of nearly fifty young bovine animals, and, on the very day of my agent's return, I vaccinated three of these, on the next day two, and so on till I had nearly exhausted my supply of virus in the vaccination of nine or ten animals. The success of these early vaccinations was perfect, and a sufficient proof of the accuracy and fulness of the instructions which my most careful agent had brought from Paris. In no one instance did these animal vaccinations fail. Although, in most of the animals, but very few vesicles were developed, in none of them were they entirely absent. I was, of course, put in possession of ample supplies of animal lymph, and devoted myself to daily vaccinations of infants, some exclusively with the animal virus, but most of them on one arm with the old stock (that of the National Vaccine Institution of England), and on the other with that from the heifers. I was

soon, from daily careful observation of these very numerous vaccinations, enabled to judge of the apparent merits of the new lymph in direct contrast and comparison with those of the old long humanized stock, of which I had constant experience for twenty-five years, and, from my devotion to the specialty of vaccine propagation, for thirteen years this experience was one of every day, almost every hour.

I must say here that my entering at all into this experiment of animal vaccination was a necessity of my position. I was constantly appealed to, as an authority on such points, for information on a subject in regard to which notices were continually appearing in the medical journals. I could only answer, as I did in hundreds of instances, that I had no absolute personal knowledge of the new method; that I had read all that I could get hold of; and that the result of my reading was a want of confidence in the innovation. I had formed my opinions on the English blue books, and particularly on the famous report of Dr. Seaton in the twelfth volume of the reports of the medical officer to the privy council. It was very annoying to be thus appealed to, and to be able to return to inquirers but an echo of the opinions of others. For two years previous to June, 1870, I was provided with letters to our minister at Paris, and to leaders of the profession there, and daily watched for an opportunity to go myself to Europe in person. No such opportunity, however, occurred; and in June I sent my special agent, who returned in September, as above narrated. As soon as I had anything to communicate to the profession I did so. On the 20th of October (twenty-eight days after the return of my agent) I published, both in the *Boston Medical and Surgical Journal* and the *Boston Journal*, an account of what had been done, and an offer to the profession of an opportunity to observe for themselves the peculiarities and, as I already perceived, the great advantages of the new method of vaccination. The first physician who followed my example in the enterprise of propagating animal virus was Dr. F. P. Foster, of New York, to whom I gladly furnished supplies of virus and every assistance in my power. Dr. Foster, in his official position in connection with the New York Dispensary, established a "SERVICE" of heifer vaccination, which, in that position, and lately as a private enterprise, he has continued with gratifying success. Dr. Foster and myself had the field to ourselves for some eighteen months.

The variolous epidemic which prevailed in various parts of the country, and reached its acmé in 1872-3, produced a very extraordinary demand for virus. A great many physicians were induced by this demand to undertake the vaccination of animals, and the distribution of the virus thus obtained. Many dealers also perceived an opportunity to make money, and employed medical students, clerks, etc., to vaccinate animals with virus obtained from Dr. Foster and myself. There is no doubt that some of the gentlemen who became my rivals had ample knowledge and ability to do so with success, and to accomplish an eminent service to the community in supplying excellent virus at a time when it was needed in amounts beyond the power of two producers to supply. It is within my absolute knowledge, however, that, in the great demand for virus during the time of the epidemic, very large quantities of so-called animal virus were sold, the failure of which did great injury to the cause of animal vaccination. At one time there must have been not far from one hundred physicians and dealers engaged in the specialty of propagating and selling "bovine virus." This competition, and reducing this important specialty to a level purely commercial, is an evil inevitable in a country like ours; and it is one which so nearly threatens the cause of animal vaccination, that my strongest motive in wishing to address this Association has been the hope that the profession may be led to appreciate the necessity of measures which may take the very important duty of vaccine supply out of the hands of mere traders. I regret that much that I have had to write on the beginnings of animal vaccination in America has been in the first person. It has almost inevitably been so, for the introduction of the new method was due to me and me only. It involved great labor and responsibility, considerable odium, large expenditure, and, in various ways, infinite annoyance, insult, and wrong; which, as it is now past forever, I can only endeavor to forget. As soon as my experiment had proved a success there were not wanting those who eagerly rushed into competition with me; this I expected, and hailed some of these competitors as fellow-workers in a field where much was to be done. I gave them every aid in my power freely, frankly, and fully, and was repaid by ingratitude, slander, and an effort, as futile as it was earnest and persistent, to rob me of the scrap of professional honor and reputation I had worked so hard to win and deserve, in intro-

ducing and firmly establishing in America a system which has already conferred infinite though hardly fully appreciated blessings; and the adoption of which, already very general, will rapidly become universal, and reflect in its full recognition the greatest honor on the intelligence and independence of the American profession and people. I shall presently try to give some idea of the extent to which animal vaccination has been already adopted in America; but, before doing so, a slight sketch of the history of the rise and development of true animal vaccination in Europe may not be without interest.

#### ANIMAL VACCINATION IN EUROPE.

I shall not attempt to notice all the experiments in animal vaccination in Europe, but only state particular experiments and practice which led directly to the method whose introduction into America has just been narrated.

In 1810, Dr. Galbiati, of Naples, published an article on vaccination from the animal as a means of insuring positive vigor and purity of lymph. This practice he had adopted some seven years before from a conviction, the result of several cases which had fallen under his notice, that syphilis might and had been communicated to the human subject in the operation of vaccination from the arm. Dr. Galbiati met with the fate of all, or nearly all those who have sought to make innovations. His proposal met with such bitter, violent, and insulting opposition and ridicule that poor Galbiati is said to have become insane and terminated his life by suicide. The seed of truth, however, did not, as it is a great consolation to know that it never *does*, perish, but his disciple, Dr. Negri, continued animal vaccination, and it became, eventually, the general Neapolitan method, and in time was also practised in other of the Italian cities. I am strongly tempted to give the interesting details of the method and practice of Drs. Galbiati and Negri, but the scope of this report will hardly permit me to do so. A full account of animal vaccination in Naples and Italy may be found in Dr. Ballard's prize essay, and Dr. Seaton's report on animal vaccination. In 1864, Dr. Palasciano, of Naples, a prominent advocate for and writer on animal vaccination as practised by his townsman Negri, addressed the Medical Congress in session at Lyons on the subject, and this seems to have been the first information conveyed to European practitioners out of Italy.

Dr. Lanoix, a young physician, was one of his listeners and was so impressed by what he heard that, soon after, he visited Naples, studied animal vaccination under Dr. Negri, and returned to Paris in Nov. 1864, with a heifer, nine months old, vaccinated by his teacher. On his journey, lymph was taken at the railway station at Lyons, by Dr. Chauveau and Dr. Diday, which was used with perfect success in the vaccination of several children and the re-vaccination of Dr. Diday himself. At Paris the subject of animal vaccination was immediately investigated by several eminent physicians and *savans*, particularly Prof. Depaul, who commenced practical experiments on the methods which were carried on at the Academy of Medicine by means of a moderate government appropriation for that purpose. There was a great deal of doubt in regard to the Neapolitan "stock" of virus. The general opinion, in spite of assertion to the contrary, being that it was retro-vaccine and not true heifer-transmitted-cowpox lymph. On the 26th of April, 1866, a case of spontaneous cowpox at Beaugency, a town in the department of Loiret, fifteen miles from Orleans, was reported to the Academy of Medicine. Prof. Depaul, "*Directeur de la Vaccine*," on the 30th of April, repaired to Beaugency. He saw there the young milch-cow in whom cowpox had appeared. In the presence of a large number of physicians and gentlemen of the neighborhood, all the facts were carefully ascertained, and a *proces verbal* drawn up in the manner usual in France. The heifer was thirty months old, white, and of the Breton breed. About four months after calving, her milker, *la femme Drouin*, was astonished one day (28th of March) to find the animal less gentle than usual; presently a *sage femme* of the place, Mme. Lambert, came in and at once remarked vesicles on the udder. She was struck by their resemblance to vaccine vesicles with which, like all French midwives, she was perfectly familiar. The *sage-femme* notified M. Daridan, a veterinary surgeon, who, associating with himself four physicians of the town, visited the animal and ascertained the existence of seven or eight vaccine vesicles on the skin of the udder at the base of the teats. There was, in the stable, another cow which exhibited no appearance of disease. A horse, separated from the affected heifer only by a thin board-partition, was most carefully examined by M. Daridan, but presented no symptoms of any disease, pustular or other. Nobody could say how old the vesicles might be for their commencement had not been noticed. The four physicians,

the midwife, and M. Daridan decided to inoculate with fluid virus from the vesicles a cow and two children. This was done on the 29th of March. A cow aged three years, and two infants of a few months old were vaccinated; in all three the operation succeeded, and was followed by beautiful vesicles at every point of insertion. All these facts were soon made known to several physicians of Orleans, among whom MM. Brechemeier and Vallet went to Beaugency on the 13th of April. They found only cicatrices on the original heifer, but on the second six crusts, a number equal to that of the insertions of virus. M. Brechemeier removed two of these, and returned with them to Orleans intending to vaccinate a calf, and he did this on his return in presence of M. Vallet and other physicians. He made six insertions, from only one of which a vesicle resulted, but this was perfect and characteristic. On the 29th of April, a third calf, aged five months, was vaccinated from this single vesicle, as well as several children. The result was completely satisfactory, and when M. Depaul examined the animal on the 30th, he found that the eight punctures had produced eight perfectly characteristic vesicles (I translate Dr. Depaul's account exactly, although it is evident that there is a mistake in the date of vaccination or inspection) umbilicated, and of the size of a large lentil. He vaccinated a calf, which he had bought at Orleans, with virus from these vesicles in twenty-seven insertions, and the next day (31st April) he departed with his heifer for Paris. She was taken to the stable of the Academy and carefully looked after. The twenty-seven insertions were followed by an equal number of vesicles, and with virus from these was inaugurated the method of true and undoubted animal vaccination. Dr. Depaul's experiences from this date are given with great exactness and at great length in publications of his own and of other physicians. In fact quite a respectable little library might be collected of the books, pamphlets, bulletins, and *comptes-rendus*, which, from that time to this, have been published for and against animal vaccination. I shall not attempt to say more of animal vaccination in Europe, but felt obliged to say what I have with a view to giving an exact and detailed account of the precise origin and history of the Beaugency "stock," a subject in regard to which the most erroneous notions have been entertained. The Beaugency virus was rapidly distributed far and wide, and commenced its important mission of regenerating and restoring the vaccine virus in

use to a standard never before so perfectly attained and maintained. The virus brought to America was, from the 258th, 259th, and 260th animal of Dr. Depaul's series, beginning with the heifer of Beaugency. It may be worth while to state the great probability that in America only the "stock" of Beaugency virus has been perpetuated.

During the Franco-Prussian war and the siege of Paris, animal vaccination ceased in that devoted city for most evident reasons. In November, 1873, Professor Depaul assured me that the virus carried from Paris by my agent in 1870 was the last that left the city, and that, during the siege, the "stock" was lost. The animal virus employed since the war is from other stocks discovered since that of Beaugency, and substituted for it for no good reason, as will be shown in another part of this report. No comments need be made on pretended "importations" of Beaugency virus since the Franco-Prussian war. One very important result has been attained by the more than eleven years' heifer-transmission of the Beaugency stock, viz., the proof that, in a period much longer than is found to involve very great deterioration and change in lymph of human transmission, true animal vaccine suffers no essential change or deterioration whatever. This result is surely of the very highest practical value, for if my firm belief is founded in truth, that there is a very great difference in the character and perfection of original stocks of cowpox, and that these peculiarities and excellences are fully and exactly transmitted by properly managed animal vaccination, then it must be evident and undoubted that the highest duty of the vaccinator is not in seeking for new stocks of cowpox, nor striving to manufacture very doubtful cowpox by variolating kine, but when an original stock, like the Beaugency, is discovered, of the highest excellence, in perpetuating it with religious care so long as the animal vaccination affords us the means of doing this perfectly. The importance of uniform excellence in the virus employed, and that such excellence should be the highest attainable, needs no demonstration. It is the most sincere conviction of the writer of this report, that precisely the two ends, of highest perfection and uniform maintenance of that perfection, can be attained, by the most careful selection of an original stock of cowpox, and its perpetuation by the careful continuance of animal vaccination by properly accomplished operators. When this truth shall come to be appreciated in its full force, and, as a



result, governments see the propriety of being the sole guardians of the sacred treasure, to be issued freely and amply for the perfect protection of the people by vaccination and revaccination, we may begin to have some faint hope of that full, perfect, universal vaccination which Jenner and his early followers always maintained would annihilate the smallpox. We know what Jenner could not know, and what time has alone taught us, viz., that vaccination before early puberty must be renewed in adult life to secure perfect protection. Our plan of smallpox annihilation would include general revaccination as well as vaccination. It may be, it doubtless is, wildly Utopian for any one to hope for an instant that mankind will ever have the good sense to do so wise a thing, but there is nothing, either wild or visionary, in the belief that variola *could* thus be annihilated. All true and just observation and deduction confirm such a belief. We can never hope for truly universal and perfect vaccination, but, just so far as we accomplish an *approach* to such an end, do we lessen danger to the community, and to such a degree that, as a matter of the highest import to the public safety and prosperity, the perpetuation of vaccine virus and its distribution for the protection of the people should no longer be a matter of private, but of public enterprise, at any rate of public and governmental care and patronage.

There is but one question for us to consider, and, if possible, answer, viz., Does the practice of animal vaccination offer such advantages over that with long humanized virus as to justify us in abandoning the latter and adopting the new method?

In order to ascertain whether animal virus is superior to that of long humanization, it will be proper to briefly state the peculiarities of the two varieties of virus as made manifest in the phenomena their use induces, draw a parallel between them, and, if possible to do so, thus demonstrate the superiority of one to the other.

PECULIARITIES OF THE PHENOMENA OF VACCINIA INDUCED BY  
THE USE OF ORIGINAL COWPOX VIRUS, OF EARLY REMOVES  
THEREFROM, AND OF THE VIRUS OF LONG HUMANIZED COWPOX.

The observations of innumerable vaccinators, and particularly of those very numerous and able men who investigated and wrote during the early dawn of Jenner's discovery, instruct us

that the use of virus direct from the original disease, and of the earlier human removes therefrom, induces a disease characterized by a very regular succession of phenomena, so often described, and so familiar to all that they need not be here described very minutely. The duration of this disease, as described by a great many of the early writers on vaccination, and by an occasional original observer during the last fifty years, who has enjoyed opportunities to study it, varies from twenty-one to even thirty-two days from insertion of virus to spontaneous fall of the crust, papulation at points of insertion at end of third or beginning of fourth day, first development of vesicle at end of fifth day, commencement of areola latter end of ninth or beginning of tenth day, decline of areola end of twelfth and often not till thirteenth or even fourteenth day, increase of growth of vesicle till the complete decline of areola, and even for two or three days after the areola has entirely disappeared; secretion evidently taking place into the periphery of the vesicle even after desiccation of its centre has commenced. Complete desiccation of the vesicle and consequent formation of crust or scab not accomplished till the sixteenth or seventeenth day; the crust never spontaneously falling before the twenty-first day, much more frequently not before the twenty-fifth day, and often its fall is delayed till the twenty-eighth, the thirtieth, the thirty-second, and occasionally even a day or two later. This crust, the result of vaccination with cowpox virus and early human removes from it, is described and figured in cases of old works and drawings as of a shape exactly the same as that of the vesicle, a circular form and a very decided umbilication or depression in centre. Its size, though not as great as that of the vesicle at its fullest development, sometimes, when the induced disease has been most perfectly and undisturbedly developed, very nearly approached it, and frequently of nearly two-thirds the size, in breadth and thickness, of the vesicle which it represented. The color of the crust is described as of a rich dark brown, sometimes of a very dark mahogany or amber. The vesicle, as of a pearly or slightly bluish tint; the areola, of a bright rosy color; the depth and vividness of which varied somewhat with the complexion of the patient and the degree of vascularity of the skin. Jenner's famous figure of "*the pearl upon the rose leaf*" was by no means an extravagantly poetical license, but is very fairly suggestive of the full development of the vesicle and areola of *vaccinia*

induced by perfect virus on the delicate skin of a fine healthy infant.

It was noticed in these early vaccinations, excepting the very earliest, that the vesicle did not tend to spontaneous rupture and discharge, more or less complete, of its contents, but desiccated regularly and in the exact form of the vesicle in its highest perfection. In these vaccinations the tissues involved were not only those of the epidermis but those of the true skin to a very considerable depth. The exact central depression indicates the point at which the dermal tissues are most deeply involved, and at this point the crust is longest adherent; the process of separation of the scab of a perfect typical vaccination being a true sloughing away of dead tissue, and not, as is generally stated, the mere falling off of a crust composed of the dried secretions of an ulcerated surface like those of rupia and many others. The lower surface of a scab resulting from a perfect typical vaccination consists of a slough, thick at the centre and thinner as it approaches the periphery, and of nearly or quite the extent of the vesicle. This is to be borne in mind as an important fact in an attempt to draw a parallel between the *vaccinia* induced by the different sorts of virus. Another peculiarity observed when the original cowpox virus in a dried state was employed, was a reluctance to affect the human system, in other words to "take." This reluctance was noticed only with the original virus and was not observed after even a single human remove. A peculiarity, which was first noticed in 1836 in the use of early removes from the cowpox of Passy, and has since been continually observed in the use of virus of very early removes from the original disease, is that it induces a more or less perfect vaccinal effect in *re-vaccination* in a very large proportion of cases. An important peculiarity of cowpox vaccination, or that with early removes, even to a very considerable number, from the cow is a very decided febrile reaction, usually coincident with the rise, development, and decline of the areola. This febrile reaction was considered of great importance by the earlier vaccinators, who held that a vaccination in which it was deficient was not to be relied on as a protection from smallpox, and when, some ten or twelve years after the inauguration of vaccination, the frequency of occurrence of post vaccinal variola excited general attention and alarm, Jenner announced as a *dictum* or law that, in all such cases, the alleged vaccination had been spurious and the infallible test of a

perfect vaccination, such as *alone* was prophylactic of smallpox consisted in the occurrence of this febrile reaction. Without it the patient was as if not vaccinated and *re-vaccination* was only admitted at all as a "test" of the perfection of primary vaccination. When *re-vaccination* induced vaccinal phenomena with febrile reaction that success was held to merely prove, according to all faithful Jennerites that the primary attempt at vaccination had been *nil*, its effect local merely, and in no degree involving or protecting the general system. This doctrine is still a very favorite one with a large class of physicians whose knowledge of vaccination is limited to the reading of a text-book or two, the work of laborious compilers, and the very imperfectly observed results of their own experience. It is not the opinion of men who have really studied vaccination. Another constant *sequela* with original lymph, or that of limited humanization, was an indelible cicatrix or scar of a peculiar and well defined type. So constant was this peculiar trace of early vaccination that its absence or the presence of a scar deficient in certain distinct and well-marked features was, till quite recently, held to be proof that vaccination had not been done, was spurious or had been in some way interfered with; in either case, protection was denied to have been secured and vaccination was to be done as if it had never before been attempted. At present, however, certain medical gentlemen of the German camel-describing sort maintain, I believe, that a clear typical vaccine scar does not by any means prove that vaccination had been once properly done, and that the most perfect possible vaccination may be followed by any sort of a scar, or none at all, or one which becomes invisible in a short time. Another peculiarity of vaccination with *very* early lymph was a frequent tendency of the vesicle to suppurate and break down, an ulcer taking its place. This ulceration often evinced a tendency to spread and be troublesome and to be accompanied by erysipelas, or erysipelatous, creeping inflammation of the skin. All the early authors, including Jenner, allude to this uncomfortable complication of vaccination with pristine lymph and suggest remedial and preventive measures. Peculiar methods of inserting the virus, as, for instance, a deep incision in which a piece of thread saturated with dried virus, was laid and retained in place by a piece of plaster; cutting through the skin and depositing lymph on the surface of the cellular tissue; arming a needle with a charged thread and passing it through a fold of

the entire thickness of the skin and leaving it there, and others equally objectionable, had, doubtless, much to do with the causation of many of these cases, still it seems sufficiently proved that vaccination with virus of very early removes and that direct from the cow was unpleasantly liable to inflammatory complications and *sequelæ*. Similar phenomena have been noticed, since the early days of vaccination, when the cowpox of Passy was discovered and that of Rambouillet and others in France in 1836-7, Estlins' stock in England in 1831, and numerous original stocks of cowpox in Wirtemberg, Bavaria, and elsewhere about the same time. Ceely has also recorded similar circumstances in his admirable work published in 1840 and 1841. Perhaps other peculiarities of original bovine and early humanized lymph might be enumerated, but those I have given will suffice. I have entered into these details because vaccinations casually received on the hands of the milkers were alone *proved* by Jenner and other observers to be absolutely and permanently protective of the adult human being from smallpox. To the phenomena of such vaccination, and of that intentionally done with the same original cowpox virus and the earlier human removes therefrom, we are entitled to look for the typical traits of the more highly protective *vaccinia*. We are justified in, at any rate, cautiously refraining from the admission that a form of the disease, *very widely differing* from that originally observed, is possessed of equal prophylactic value until such value and virtue shall be as fully proved. As all the phenomena liable to be observed from the use of long humanized virus must be very familiar to a large majority of my hearers, and those from the employment of the new or bovine sort, as well known to many of you, I hope to be able to rapidly complete this part of my work.

#### PECULIARITIES OF JENNERIAN OR LONG-HUMANIZED VACCINATION.

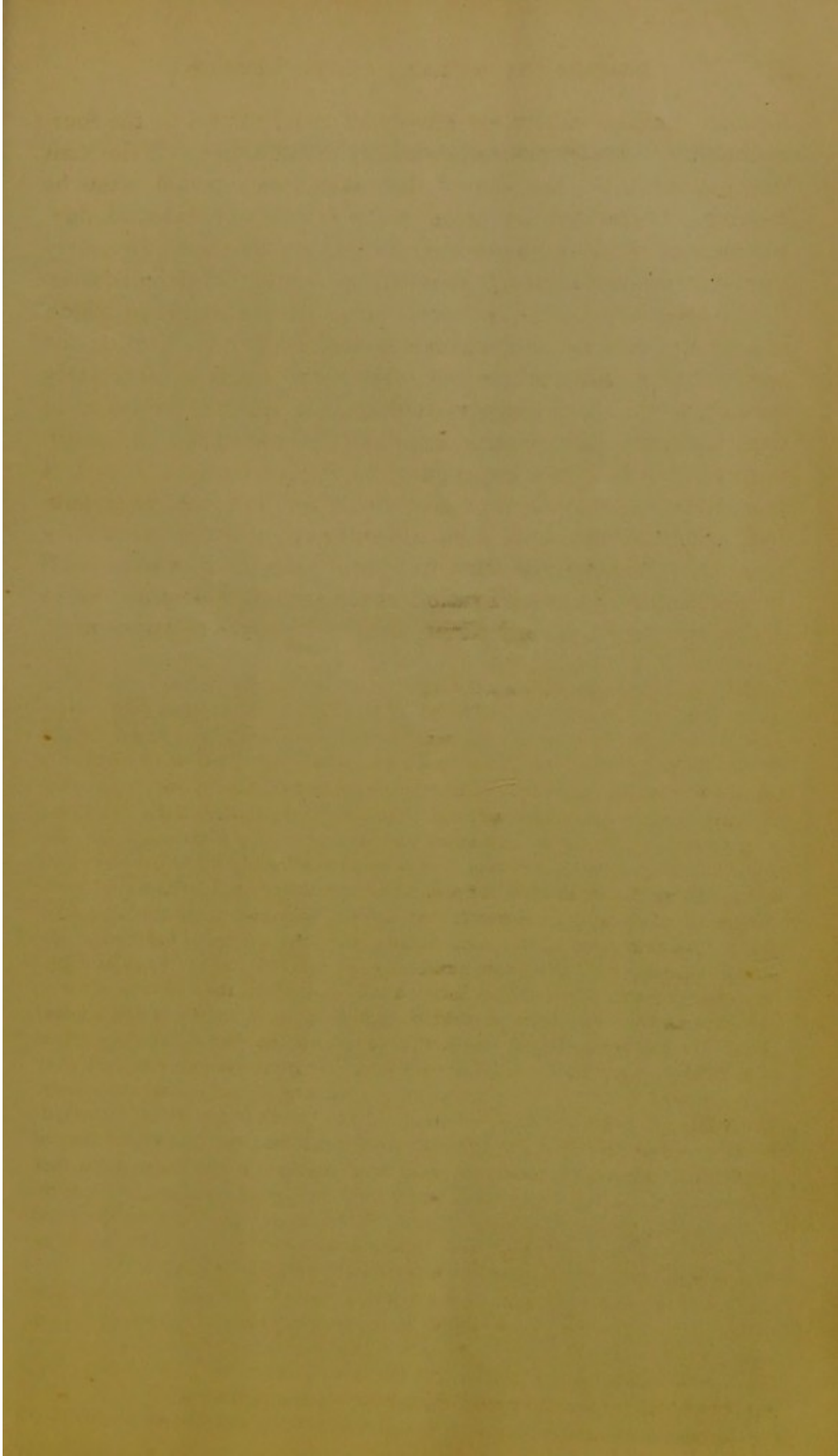
One of the most striking peculiarities of the *vaccinia* induced by the inoculation of long-humanized lymph is a great diminution in duration. This varies in different "stocks" of virus very widely. In 1859, Mr. Robert Ceely, of Aylesbury, in England, very courteously sent me, in answer to a request, twelve capillary tubes of fluid lymph. I used these in my practice, and issued virus from this source for several years to the extent of from 15,000 to 20,000 "charges" annually. The course of the

disease induced by this virus was usually eleven days from insertion till the crust fell, or could be very easily and painlessly removed. It was an unusual circumstance for a crust from this vaccination to adhere to the arm till the fourteenth day. I should have abandoned its propagation were it not for the perfect form, notwithstanding its small size, of the vesicle and areola it induced, and the exact regularity in the sequence of the phenomena of the disease, as well as the distinguished source whence I had procured the "stock." I also repeatedly tested it by vaccinating those who had been vaccinated with it with an extremely vigorous lymph, the original "stock" of which I had procured some three years before from a firm of French apothecaries in New York (Paturel & Co.). This French virus was stated to be original cowpox virus collected in the vaccine department of the Academy of Medicine. I fully ascertained that it was virus of a very early human remove from the cow, and collected as stated. During the four years that I propagated this virus it manifested the same qualities. A large, full vesicle, a vivid, broad areola, and a firm, dark, well-formed crust—never easily detached before the twenty-first, and hardly ever falling before the twenty-sixth day. I endeavored to induce at first but two, and even latterly not more than three, vesicles from this French lymph; while I often inserted that of Mr. Ceely's "stock" in six, eight, and even twelve places without the slightest apprehension of undue impression on the system. During the four and a half years that I retained the French virus, I made a great many of my vaccinations with both stocks—one on one arm and the other on the other—and each stock preserved its distinctive qualities perfectly without the slightest tendency to hybridize. At the end of four and a half years I lost the French "stock," and, failing to recover it after repeated attempts, applied to the National Vaccine Institution of Great Britain, and at various times received ample supplies of the famous stock of that admirable institution. Virus from this source I propagated exclusively for nearly ten years. This virus induced a disease, the duration of which was fourteen days, very exactly, from insertion till fall of the crust. I was obliged to ascertain very precisely the time at which the crust fell, or was capable of easy and painless removal; for on this knowledge depended my success in collecting vaccine crusts in any considerable number and in the most perfect condition. If with the

English lymph I visited my patient in the first part of the fourteenth day, I would generally find my crusts intact. If the visit was not made till the end of that day, crusts would often be missing. If the visit was made on the fifteenth or sixteenth day, the harvest would be very scanty or entirely deficient. In nearly twenty years of this sharp look-out for virus in different forms, it was necessary for me to inspect arms with a frequency which is certainly unusual, and which was the means of informing me very fully on many points not often very closely or accurately investigated. I will not give further details of the varieties in duration and other phenomena which I have noted in the different "stocks" I have propagated at various times, although it has always seemed to me a very important and interesting subject, and at another time I should be happy to write more fully upon it.<sup>1</sup> The fact that two different "stocks" of vaccine will induce *vaccinia* whose duration shall vary so widely as twelve and thirty-two days, and differ also in the times of appearance,

<sup>1</sup> The plate is a copy, by the heliotype process, of exactly half the dimensions of the original illustration, by Chazal, of the difference observed between the *vaccinia* induced by virus of the old "stock" introduced into France by Dr. Woodville in 1800, and continued there by human transmission for thirty-six years, and that from the use of virus of an early human remove from the cowpox of Passy. I have preferred to make no alteration or translation of the inscription on the engraving, but to give an exact copy, except in size, of the original. The upper and third rows are drawings of an arm on the fourth and following days to and including the nineteenth, and also of the twenty-fourth, vaccinated with the new virus. The second and fourth rows are of a vaccination, on the same days and on the other arm of the same patient, with the old enfeebled virus. Although the copy will, if examined carefully, give a good idea of the great difference observed after the tenth day between the results from the two sorts of virus, the contrast is by no means so evident and striking as on the larger original plate. On the twenty-fourth day it will be noticed that two of the three crusts of the Passy "arm" have disappeared. Bousquet particularly states that they were removed by the mother for a special reason, and did not *fall* spontaneously. The crusts generally remained adherent till the thirtieth day if not disturbed. In my own vaccination of patients both with virus from the animal and that of the English vaccine institution, repeated many hundred times, it was noted that the crusts from the first were much larger than these representations of those resulting from the use of the Passy lymph. They were of almost invariable typical form and color, and, if undisturbed, remained attached to the arm till from the twenty-sixth to sometimes even the thirty-fourth or thirty-fifth day.

I have sent a copy of Bousquet's original pamphlet and plate to each of the public medical libraries of the United States, that students of vaccination may have an opportunity to consult a work not only rare, but of real and permanent importance and value. A similar gift has been made of Decantelen's beautiful lithograph and the accompanying fragment of his proposed work.





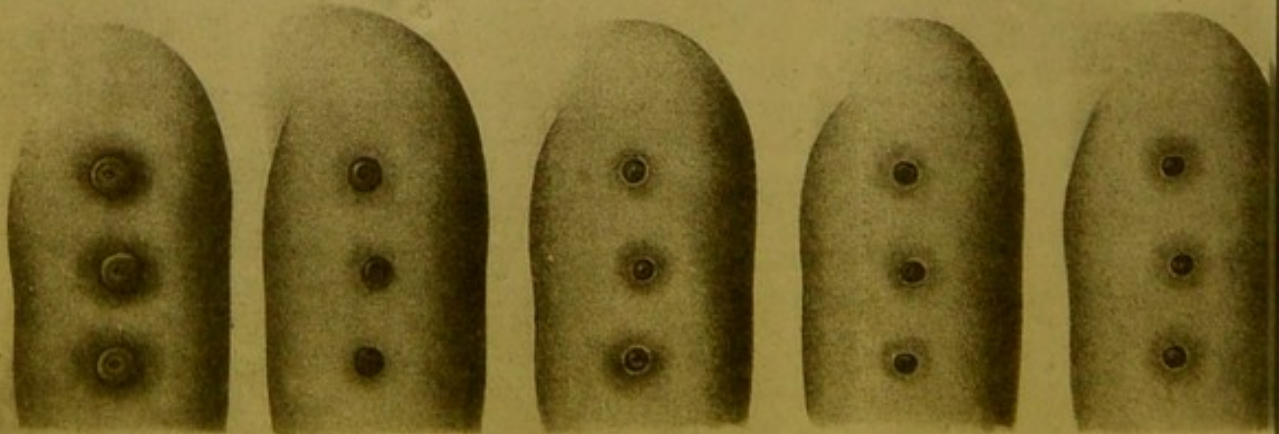
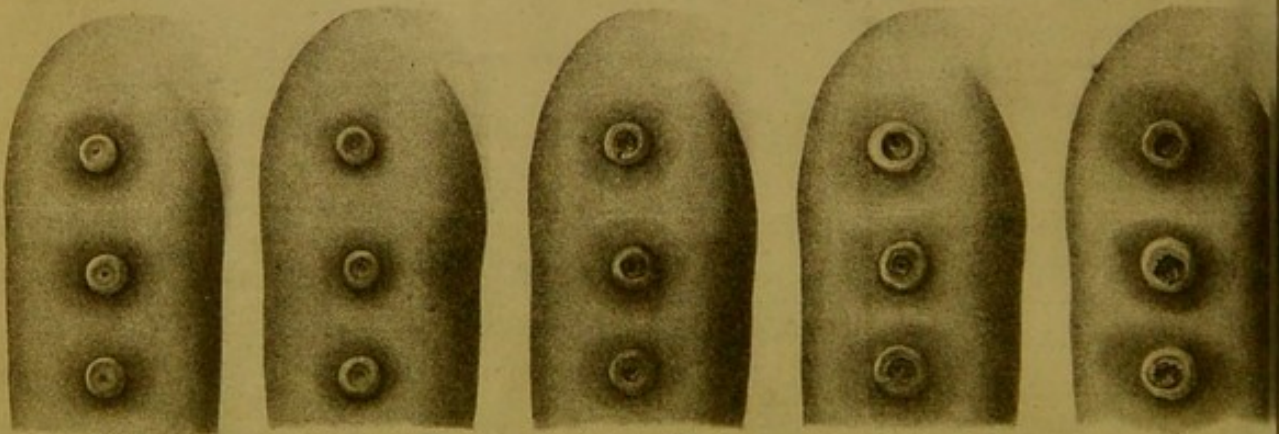
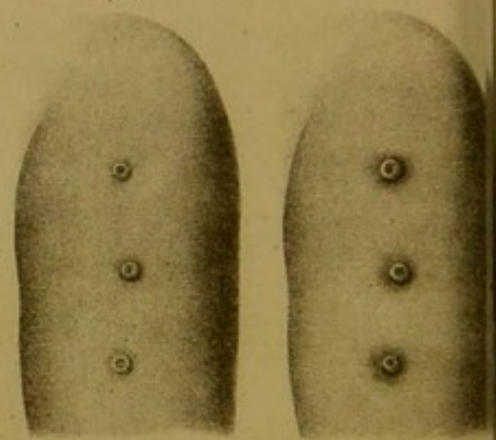
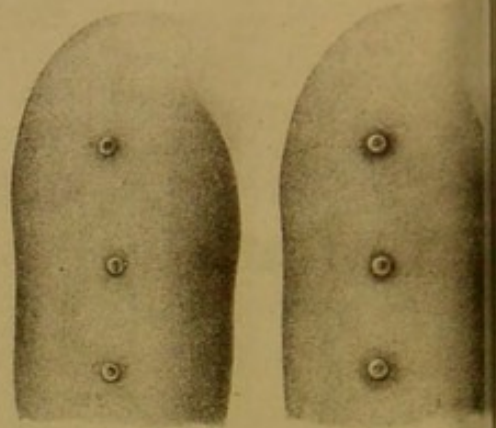
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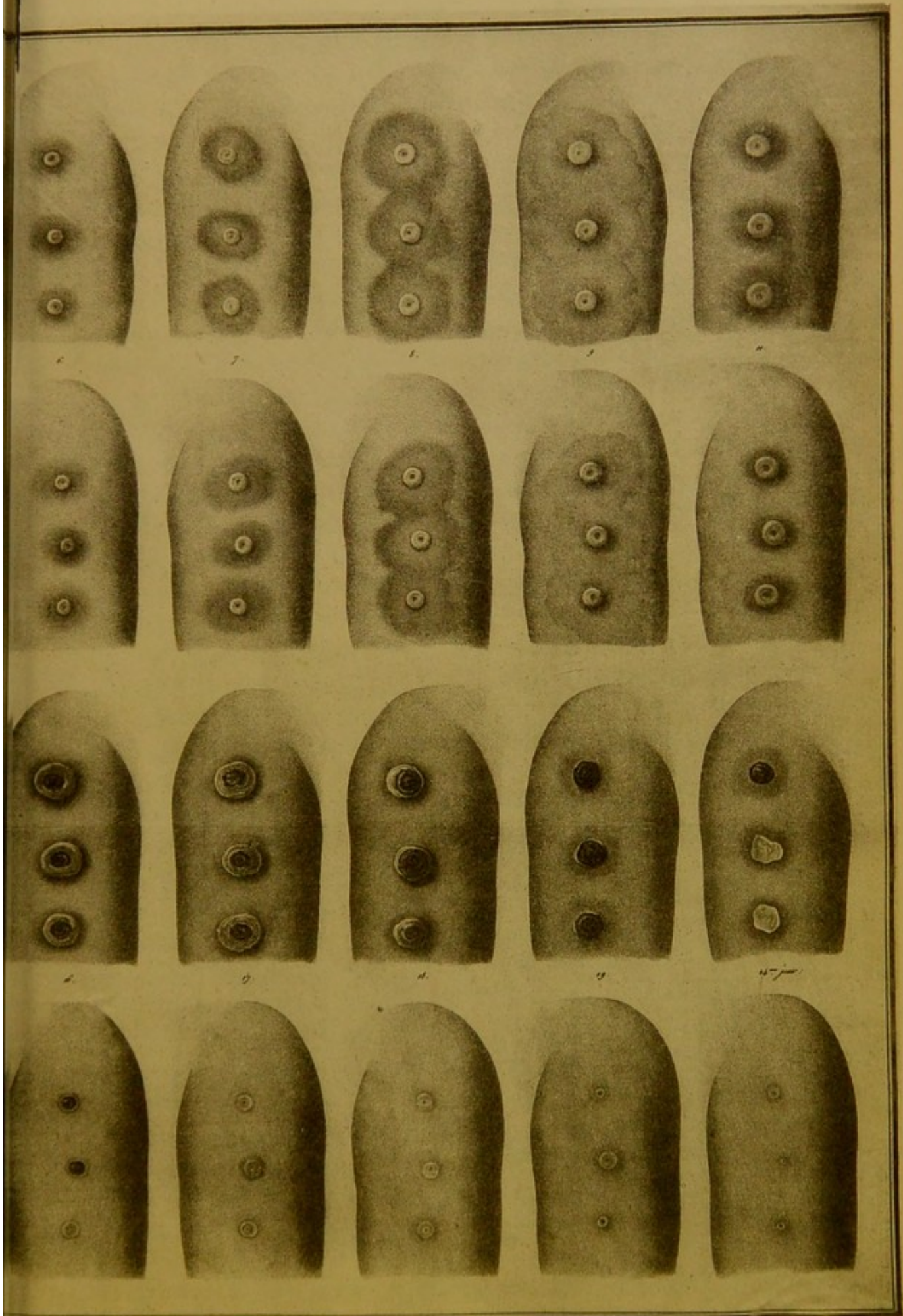
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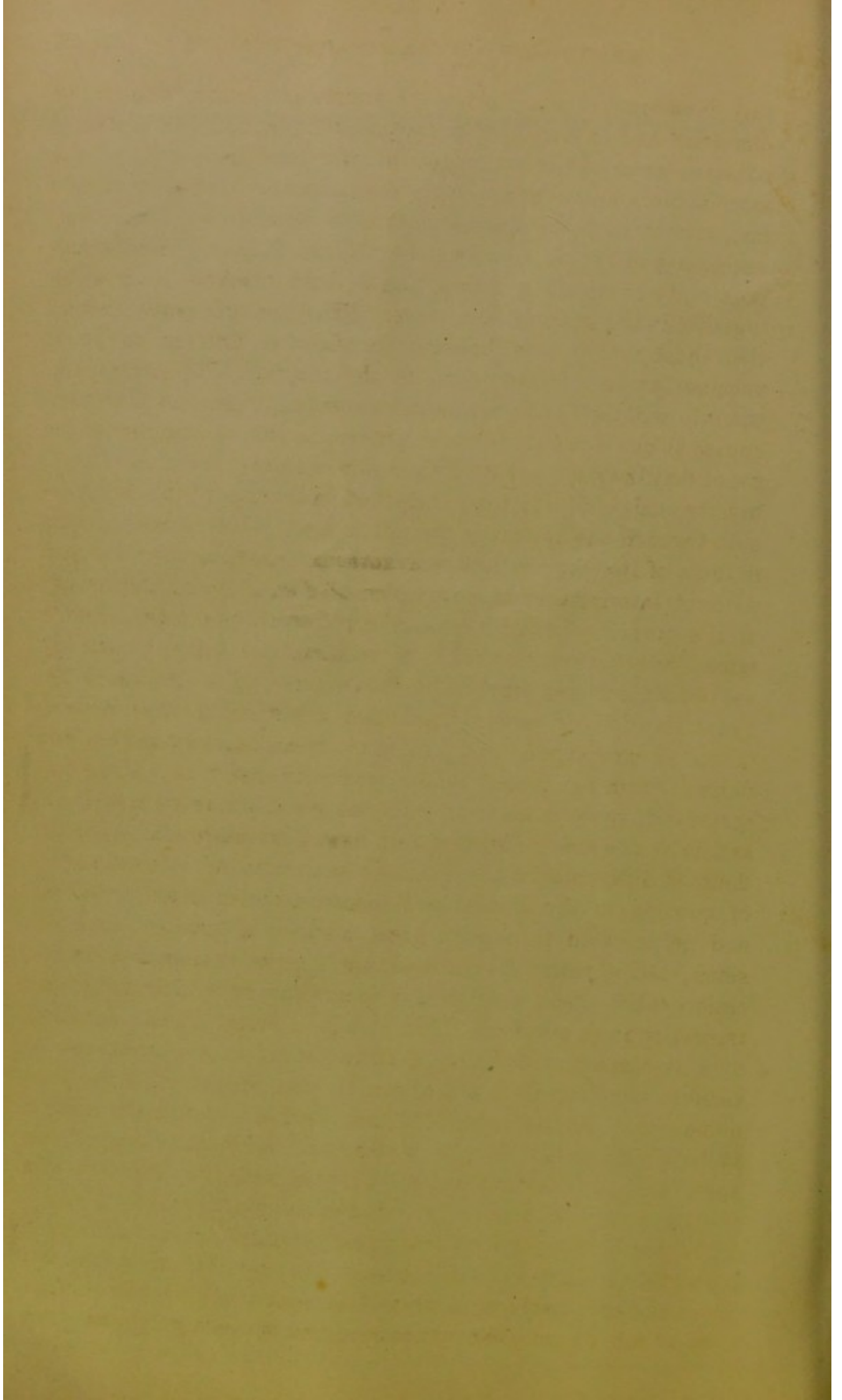
## Vaccine

*De l'ancien (1800)  
et du nouveau Virus*

1856.







full development, and decline of vesicle and areola, and in the character and intensity of constitutional reaction, yet perfectly constant each to its own type, though both developed in the same subject, seems to me more than a merely curious scientific fact, and to afford an answer to those writers who maintain that vaccinia and variola are entirely distinct diseases, without any possibility of common origin, *because* both diseases, progressing together in the same patient, present differences not really greater than those seen to exist between the effects of different stocks of vaccine lymph. It seems to me that the fact that *variola* and *vaccinia* will, as I have repeatedly observed, pursue each its own course at one time in the same patient, is the one unanswerable proof that they are essentially the same disease; but one of them mysteriously and variously modified and changed by transmission through the system of the milch cow. What other instance is there of two *entirely distinct* exanthems pursuing such a course without interruption or suspension of the course or phenomena of the other? I may mention here that at one time I maintained five different "stocks" of vaccine, and that I frequently vaccinated patients from all five. On the eighth, or any subsequent, day I could instantly pick out each from the five vesicles on the patient's arms; and a score of crusts thrown together and derived from all these "stocks" could be easily and accurately sorted out by a familiarity with the peculiarities of size, form, and color of each. There is, as I have previously stated, an undoubted difference in the character and vigor of original stocks of cowpox in the animal, and these peculiarities are preserved and perpetuated through a great number of human transmissions; but it cannot be doubted that a great change and modification takes place, very gradually and imperceptibly, from one transmission to another. This change is always in the direction of a *shortening* of the period during which the phenomena of *vaccinia* are developed, a decrease in the intensity of those phenomena, and in the effect of their evolution upon the human system. Much that I have written will serve to illustrate this, and I need not, for my present purpose, dilate so fully on this subject as my interest in it would impel me to do. In brief, it may be said that virus of long humanization induces a disease of much briefer duration and intensity than original and early virus. In an extreme instance, to which I have alluded, the whole duration, to fall or complete desiccation and loosening of crust, was

but eleven or twelve days; the areola began on the seventh and often on the sixth day, and had perfectly declined on the ninth day. This was a very extreme case; but the virus of the Jennerian "stock" of the English Vaccine Institution—the very finest lymph of long humanization of which I have ever had experience—induced a disease whose duration, from insertion to fall of crust, was often included in fourteen days, the areola commencing at beginning of eighth or end of seventh day. This may be given as the result of virus which, by a most exact and religious care in selection of vaccinifers, has been kept through a very long series of human transmissions in a condition of vigor and approach to original perfection quite beyond that of any other lymph of long humanization of which there is any record; but how very great the difference between the *vaccinia* induced by its use and that where original or early lymph is employed! This difference is not made manifest in the duration alone, but in every other respect. The crust resulting from vaccination with very long-humanized virus is very much smaller, very often fails to perpetuate the umbilicated form of the vesicle, and very often, indeed, fails to form at all. The reason for this is to be found in the very much greater delicacy of the vesicle. The dermal tissues are but very superficially involved; the crust consists, in all but rare exceptional cases, of epidermal tissues only. The true skin is not involved at all, or only very superficially. The crust forms and falls rapidly because it includes no slough, the attachment of which to the living dermal tissue holds it fast, and the separation of which is by a process requiring many days to accomplish; and the same shallow central attachment permits the separation of the epidermis, from the secretion of lymph, and so effaces the umbilication. The vesicle rapidly dries into a crust, because from the commencement of the formation of the areola secretion into its cells ceases, and what has already been secreted quickly desiccates. The result is naturally a very small, thin crust. The extreme tenuity and weakness of the tissues which contain the lymph lead to the rupture of the vesicles from any slight external violence, and, indeed, without this, in a very large proportion of cases, the vesicle bursts from the distension produced by the virus secreted into its cells. When this takes place, anything like a typical vaccine crust is, of course, wanting; and one of the numerous petty annoyances of humanized vaccine consists in the establish-

ment of an ulcerating surface covered by a friable scab, which falls every two or three days to be renewed and fall again, and so on for many days and often weeks, or even months. Fluid virus, escaping from this ruptured vesicle and drying on the skin about it, produces a very disagreeable sort of secondary vaccination, an involuntary "Bryces' test," for which the physician is often blamed most unjustly. If a woollen fabric comes in contact with one of these vesicles of long humanization, it almost invariably induces its rupture; the albuminous contents escape freely, and, drying, glue the dress to the remains of the vesicle. When the dress is removed, the vesicle is again torn open, again to pour out lymph and serum and blood; and this process, often renewed, is a source of annoyance so frequent that he must be a very young vaccinator, if there is any in this audience, who has not often encountered it;—an annoyance which, in popular belief, results from the use of impure virus, but which happens continually when long-humanized virus is used, no matter how pure, how carefully collected, or how skilfully introduced. The greater the number of human transmissions which separate the virus from its original source, the greater its liability to these unpleasant complications. The use of virus of very long humanization does not develop anything like febrile reaction, even when many vesicles are produced, save in very exceptional cases—a fact of vast importance if the law of Jenner and the firm convictions of the earlier vaccinators were founded in anything like truth. I have by no means exhausted the enumeration of the many points in which the *vaccinia* induced by the virus of very long humanization differs from that observed and described by Jenner, Willan, Pearson, Woodville, and an army of early writers on vaccination.

I must mention erysipelas among the occasional complications and sequelæ of vaccination with humanized lymph. When I come to speak of the peculiarities of animal virus, I shall notice this at length, merely stating now my firm belief, contrary to former conviction, that erysipelas is a disease *peculiar to humanity*, that it is capable of inoculation from one to another, that vaccinal erysipelas is conveyed, in *most* cases, from one patient to another just as is *vaccinia*, and that, as a consequence of all this, vaccinal erysipelas is peculiar to vaccination with humanized virus, and not capable of transmission from a bovine to a human animal. The evidence I have accumulated which has led me to

these convictions is complete and ample, but its full examination cannot now be attempted. I find, however, that I have omitted a very important matter, viz., the infinite variation from the typical scar observed as resulting from the use of virus of different degrees of humanization. It seems to me indubitable that the dermal tissues are involved more or less deeply as the virus used in vaccination is at a lesser or greater number of human removes from the original source. The differences between the scar produced by vaccination with the virus obtained from Mr. Ceely, and that to which I have referred as produced at the French Academy was constant, and full as great as that displayed by the phenomena of the eruption which produced them. Contrary to a very fashionable opinion, I state very distinctly that a perfect typical vaccination of a duration and intensity at all approaching a proper standard, and which has not been interfered with in a very unusual manner, results in the production of a scar as distinct and defined as if stamped by a sharply cut die, and that the scars of a hundred such vaccinations are almost as like each other as the impressions on a hundred coins fresh from the mint. If the arm of a person vaccinated, no matter how long before, does not present a scar of this description, the evidence is sufficient that that person was never properly vaccinated, that the so-called vaccination was done with lymph more or less deteriorated, or the person was in a condition which prevented a full and perfect evolution of the protective disease, or the vesicles were broken or otherwise injured so as to interfere with the proper development of the eruption. This matter of the vaccine scar seems to me of very great importance, and I think that the sooner the profession accept as a fixed fact that, *as a general rule*, there is a direct relation between the perfection of a vaccination, and the typical perfection of the resulting scar, the better.<sup>1</sup>

<sup>1</sup> I wish here to record the tribute of my admiration of a forgotten author, and an unfinished book. In 1851, Dr. Denarp Decanteleu published at Paris a large and wonderfully accurate and beautiful lithographic drawing; and the first and only *livraison* of what proposed to be a book which that drawing was intended to illustrate. No one wanted the work, and so only that single number was ever issued. The title of the book is *Monographie sur les Cicatrices de la Vaccine*. The drawing represents distinct varieties of the vaccine scar most carefully classified according to the system of Lamarck. The drawings are of wonderful delicacy and accuracy, and were copied from a marvellous collection of casts in stucco, taken from the arms of a large number of subjects selected from a very much larger number. This collection of casts of vaccine scars, colored after nature, the

## PECULIARITIES OF HEIFER-TRANSMITTED-COWPOX VIRUS.

I shall not be obliged to take much time in describing the phenomena of vaccination with the heifer-transmitted-cowpox virus.

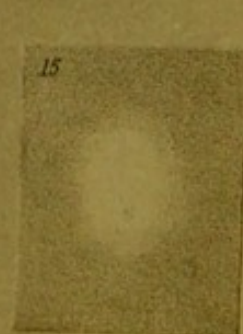
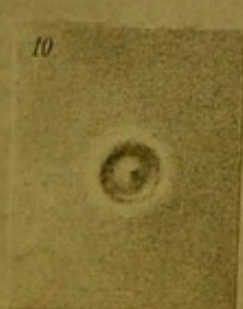
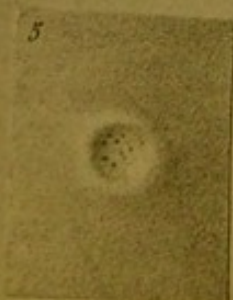
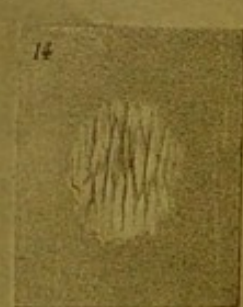
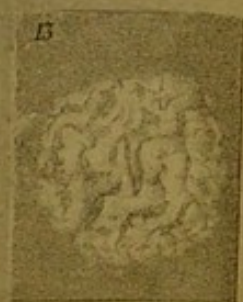
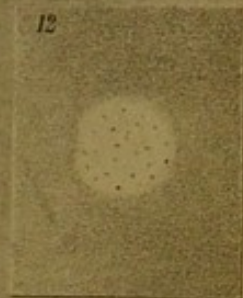
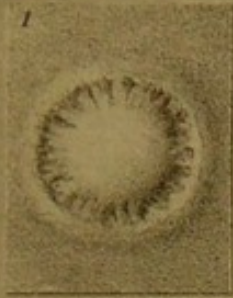
writer refers to, and offers for the inspection of his readers as corroborative of the accuracy of his drawings. In juxtaposition with these representations of vaccine scars are given exquisitely accurate drawings of every variety of scar, as of leech bites, burns, cauteries, issues, boils, etc. etc., so as to make the differential diagnosis clear and manifest. The few pages of the single number of text give evidence of the author's genius, vast labor, and enthusiasm, and of the great curiosity and value the work would have had if it had been completed. As the fragment now remains I consider it a very precious relic. I sent to Paris to find if it were possible to buy or see the MS. of the complete work, but Baillièrè (the publisher) knew nothing of it, or of the collection of casts. All was unknown or forgotten, except that Dr. Decantèlèu had died not long before my writing. I purchased from Baillièrè all that remained of the edition, and it has given me great pleasure, from time to time, to give one of these remarkable drawings to a physician or student who could appreciate it. I allude to this publication here because it illustrates a fact which I insisted upon long before I had seen Dr. Decantèlèu's fragment, viz., that the variety of so-called vaccine scars is very great, but that there is but a single type of scar indicative of a *perfect* typical undisturbed vesicle having existed, and that the variations from that type are due (1) to an imperfect development of the vesicle from use of virus more or less enfeebled by long human transmission. (2) Some morbid condition, either transient or permanent, of vaccinia preventing the proper evolution of disease. (3) Some external force, as scratching, friction of clothing, etc., which has lacerated or otherwise injured the vesicle. The first class includes, probably, ninety-nine per cent. of all the variations from the perfect type of scar. Unless a patient is in the last condition of imperfect nutrition, good virus will induce a perfect vesicle and a typical scar, and external violence will seldom prevent a good vesicle leaving a respectable approach to a perfect cicatrix. During the whole of our late war I had peculiar opportunities to examine the arms of a large number of soldiers vaccinated in childhood in this and almost every European country, and also of a very large number of citizens of three Southern cities in which a variolous epidemic was raging. Among these I repeatedly encountered almost every variety of scar figured by Decantèlèu, and it was very noticeable that the character of the cicatrices of men from Wirtemberg, Bavaria, and some other German States, were far superior to those in British recruits; while these latter were superior in character to the American scars. These latter were fainter and less typical than any other. My belief has very long been that in no country has vaccination been carried on less satisfactorily than in the United States. Not so far as the percentage vaccinated, for, in the older States, that is undoubtedly large, but in the character of vaccination done. Certainly, my experience in examining the arms of recruits, from 1861 to 1865, most thoroughly confirmed this belief. An extended observation, too, of the great prevalence of variolous disease in young Americans, both white and black, protected by a single primary vaccination, strongly confirmed a belief in the imperfect character of even that single operation. Any physician, old enough to remember the extreme difficulty experienced in getting

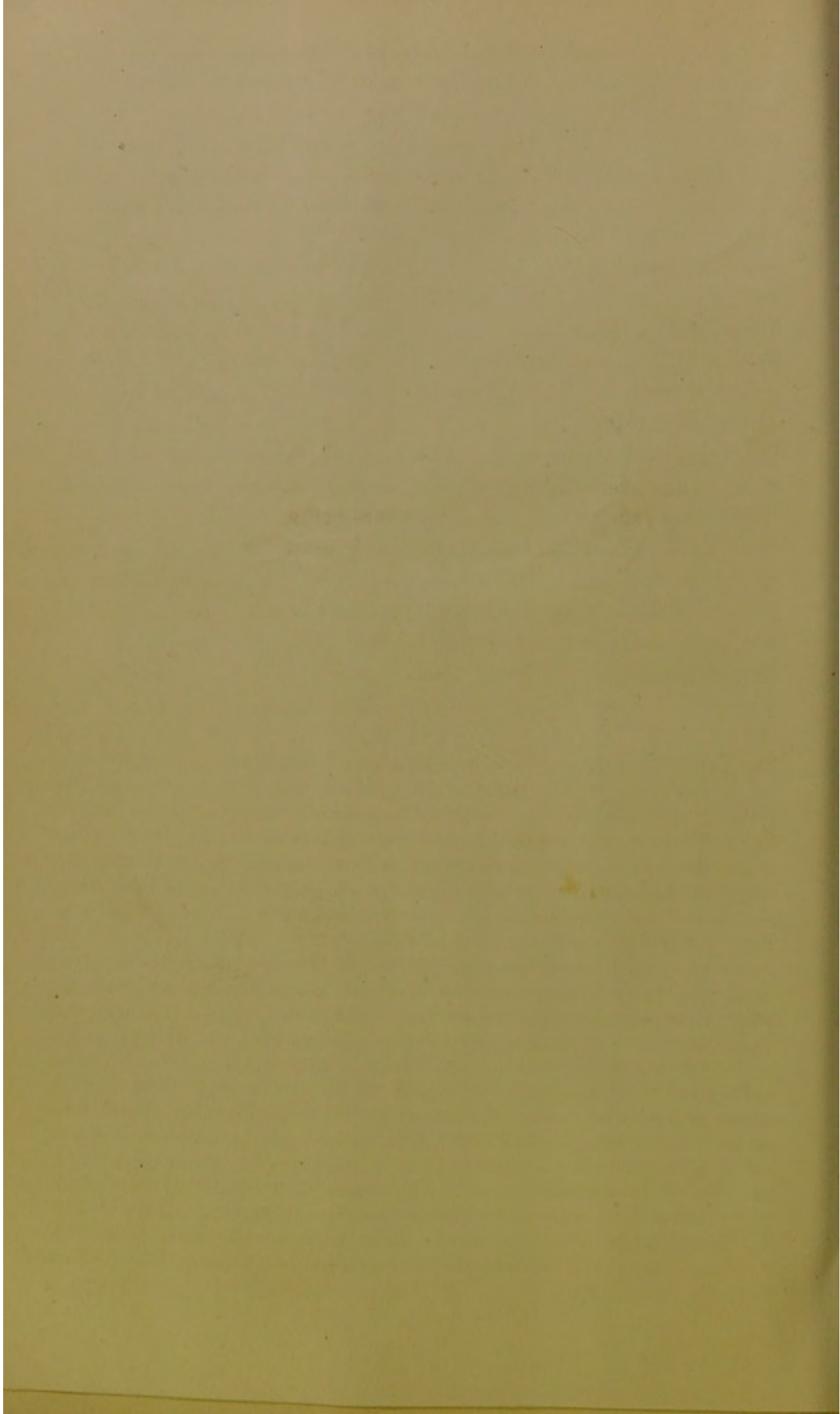


I had not made and fully observed half a dozen human vaccinations with the animal lymph before I fully recognized its corres-

even tolerable vaccine virus for thirty years before the war, will not wonder at the faint and imperfect cicatrices of recruits vaccinated within that time. When we reflect that even in our most pretentious medical colleges vaccination was not, till lately, thought worth teaching, and the protection of the people had to be done by men who had never even learned what a perfect vaccine vesicle was, it is hardly to be wondered at that vaccination in America has been done very badly. The point is one of prodigious importance, and, as the sparsely populated regions of the West and South become rapidly filled with dense masses of population, the result of imperfect vaccination will become more and more frequently evident, as it is often already in California and elsewhere, in repeated variolous epidemics.

Dr. Decanteleu's drawings are so fine and accurate, their study seems capable of being as useful in giving clear and correct notions on a subject, in regard to which very shallow theories are abroad, that I wish I could offer a copy of the whole plate as an illustration of this report. The size, however, is so great that if reduced to that of the page of the *Transactions* the separate designs would be too small for ordinary vision. The special committee to which the report was submitted agrees with me in thinking that a copy of the drawings of the typical scars which Dr. Decanteleu exhibits, each as a type of its species, will be acceptable and useful. They are accordingly inserted here, and of very nearly the same size as in the original drawings. Dr. Decanteleu divides vaccine cicatrices into fifteen species; these drawings illustrate a perfect type of each species. In the original plate there are representations of over sixty more scars, but these are divided into groups, each group being of varieties of one of the fifteen species. The first scar represented gives a very good idea of a very fine perfect scar of a vaccination with vigorous bovine lymph, or of a very early human remove therefrom. Such cicatrices are now very common in America; they were not so before the introduction of animal vaccination. Dr. Decanteleu states that he found such scars in twenty-four per cent. of all examined by him, a proportion much larger than would have been found, at the time Dr. Decanteleu wrote, in examining American vaccine cicatrices. That they were found so frequently in France is due to the frequent introduction into that country, since 1836, of new stocks of cowpox virus, while in this country the introduction of new stocks of virus was, till lately, almost unknown. Just in proportion to the frequency with which vaccine scars of this type are noted may we be assured of the excellence of the vaccinations. Although cicatrices of a different species may follow a good and protective vaccination, these alone give absolute evidence to that effect. An entire absence of the minute *foveolations* or pits usually described as characteristic of a good vaccine scar will be noticed. The peculiarities of these typical cicatrices of perfect vaccination result from the extent to which the dermal tissues have been destroyed. A smooth centre surrounded by rays or bands of connective tissue. In the centre the entire thickness of the skin is destroyed and the result is a smooth cicatrix, the bands of connective tissue evince the effect of nature to restore the skin, deeply but not entirely involved. The subject does not, perhaps, seem to the reader one in which much could be said, but much less interesting and important topics have been the texts of many ponderous essays. Such an essay I once nearly completed on the vaccine crust and scar, but, warned by Dr. Decan-





pondence in every minute particular with the *vaccinia* described by Jenner and the fathers of vaccination, whose works and drawings I possessed, and with which from day to-day I compared them. As the virus received by me was from the 258th, 259th, and 260th animal of Prof. Depaul's series, commencing with the heifer of Beaugency, I believed that there could have been no deterioration in four years and a half of transmission through so many animal systems, and indulged a hope that, in a much larger animal series, no tendency to deterioration might manifest itself. Every animal and human vaccination I have since made has confirmed that belief and hope. During last winter I carefully tested a series of vaccinations from the 570th animal of my own series, the 830th since the original case, and could detect no shortening of the duration of the induced disease, no indication of change, however slight, from the standard of excellence observed in my first vaccinations over six years before. I have since carefully observed several vaccinations from different animals, and found the same exact regularity in the succession of phenomena, in perfect development of vesicle and areola, febrile reaction and duration of disease. As over eleven years of constant bovine transmission have elapsed since the original case of cowpox at Beaugency without the slightest indication of deterioration, and

teleu's fate I never offered it to the profession. I can give no approach to such an essay here, but would call attention to the difference in the drawings, the gradual disappearance of the smooth central cicatrix, and the stellate bands of cicatricial tissue, and appearance of minute *foveolations* or pits. This gradual change indicates a less and less destruction of the skin. The little pits are nothing but the remains of cutaneous follicles, and where the vesicle is most perfectly developed, these are entirely destroyed and leave no trace. One of the drawings (10th) exhibits a sort of island in the centre. I have seen many such scars, although Dr. Decanteleu considers it one of the very rarest of forms. They result from the use of very much enfeebled lymph; the development of *vaccinia* is not intense enough to entirely arrest the nutrition of the skin, and so induce the slough which I have maintained to always accompany a perfect development of the vaccine vesicle. The fifteenth drawing is of one of those smooth spots which we often see as the only evidence of vaccination. Such traces indicate an extremely superficial destruction of the skin. The twelfth drawing gives what is generally considered a typical scar, but it is that of an extremely feeble and imperfect development of *vaccinia*. This has far exceeded the usual limit of a note, but the subject is one which seems to me not sufficiently noticed, and I hope what I have written, with the assistance of Dr. Decanteleu's drawings, may direct the attention of the profession to a curious and, in connection with the very important question of change and deterioration in vaccine lymph, not unprofitable field of observation.

as the period within which very great change has always been noticed to take place in vaccine "stocks" through human transmission is much shorter than this, I think that we are justified in assuming that original cowpox transmitted through a series of selected young bovine animals will not manifest the tendency to change which has always been noted in virus of long humanization. I have never in any case of vaccination or re-vaccination with the animal virus observed the violent inflammatory and erysipelatous complications so frequently noted when original cowpox virus and that of very early human removes has been employed, and that I have not, is explained by the fact which was observed and published by Ceely in 1840, viz., that this tendency to undesirable intensity in the original disease is modified by successive inoculations of young animals. Ceely carried the original cowpox by inoculation through a series of eleven animals, and, in even that limited number, observed a constant diminution of objectionable qualities as tested by human vaccinations. His observations on this point led him to express the confident belief that if cowpox should be carried through a much longer series of selected young animals, this tendency to too intense and irregular action would be entirely got rid of. This prediction of the most able and distinguished investigator of cowpox in the animal since Jenner, has been most perfectly and absolutely fulfilled. The disease now induced by animal virus after eleven years of bovine transmission, is marked by a certain intensity and perfection of development, but not the slightest tendency to violent inflammatory suppurative action, or ulceration, or erysipelas in any form or degree. The regularity and constancy with which *vaccinia* thus induced passes through every stage to the formation of a crust of typical form and color, which remains adherent till from the 24th to the 30th day, and is very rarely capable of safe and easy removal so early as the 21st day, is far beyond anything that I have ever observed in the use of any stock of humanized virus for even a single year. In the use of animal virus, the cases in which a perfect typical crust fails to form, or, falling, leaves anything but a perfectly healed surface and a clear typical scar, are very exceptional and due to a very unusually morbid condition of patient, or some accidental injury to the vesicle. In vaccination with the best and most carefully managed "stocks" of humanized virus results were very different. Sometimes for weeks, even months together, such vaccinations would result in a

fair development of good crusts, and then again, for a long time, hardly a single perfectly satisfactory one would be found in fifty cases. This difference in what I consider a very important quality in the two different stocks of virus, was made very evident in many hundreds of vaccinations which I made during the first three and a half years after I commenced animal vaccination. During those years I issued three different sorts of virus, viz., direct from the animal, of one human remove therefrom, and the old long-humanized virus which I had so long propagated. To enable me to supply these, I made almost all my vaccinations on one arm with the animal virus, and on the other with the old stock. It was by a constant and careful observation of such cases that I arrived at very decided convictions in regard to animal vaccination, which could hardly have been so perfectly reached with less extensive opportunities. Every one of those vaccinations was an experiment, and it seems hardly possible that certain deductions made from these, continued almost daily for nearly four years, should be erroneous.

NOTE. (See PLATE.)

On the "cowpox of Passy," as illustrative of the wide variation of the *vaccinia* induced by virus of early removes from cowpox, and bovine virus from that from the use of virus of long humanization.

I should have endeavored to procure, for the illustration of this report, accurate drawings of the progressive development, on a series of days, of the *vaccinia* from animal virus, and that from the virus of the "stock" of the English Vaccine Institution, were it not that an admirable series of designs already exists which illustrates very perfectly what I desire. I allude to the engraving which accompanies a famous monograph, from the pen of Bousquet, "ON THE COWPOX OF PASSY." A copy by the heliotype process of exactly half the size of the original is here inserted. I need say little of this illustration. It represents very well the contrast between the *vaccinia* of bovine lymph and that of the English "stock." In the early and very numerous vaccinations which I made with these two "stocks," on which my knowledge of the subject is chiefly based, the contrast was fully as marked; for, although the English virus had not reached so extreme a point of degeneration as the French virus in use before 1836 (derived from virus introduced into France in 1800 by Dr. Woodville, and representing probably 38 years of uninterrupted human transmission), the *vaccinia* from animal virus was even more "*superbe*" than that resulting from a virus, not far removed from cowpox, but still separated from it by several human transmissions, and already a good deal declined in vigor.

The monograph is probably very rare, as no copy was in the great collection of works on vaccination in the greatest medical library in the world (the library of the surgeon-general's office at Washington) till I contributed one. On this and all accounts, I am much gratified that the Publication Committee of the Association not only consented to, but desired, the reproduction of the engraving

which illustrates that paper. It seems to me in every way well that so carefully prepared and undoubtedly accurate a representation of the very great difference between two developments of the vaccine disease should be preserved and multiplied for the study of those who doubt or deny that any particular change is produced in vaccine virus by long human transmission.

Bousquet's admirable report so perfectly illustrates much that this report maintains that I should be glad to offer a translation of the entire pamphlet; but my MS. has already grown so formidable that I must deny myself the pleasure of more than two or three brief quotations. At some future time I hope to publish a monograph on the deterioration of *vaccinia* by long human transmission. With a view to much increasing the value of such a work, and offering to the profession a most important and almost forgotten tract of a great writer on vaccination, I intend to bind, with each copy for presentation, a copy of Bousquet's original monograph and plate. For this purpose, I purchased from Baillière, in 1871, the entire "*remainder*" of the edition. One or two short quotations I must give here, because of importance in relation to that judgment of Dr. Seaton in regard to the *vaccinia* of animal virus, which has had so powerful and pernicious an effect in hitherto preventing in England the introduction or adoption of the new method. That very able writer, in his well-known report (1869), states that he observed no more difference between the vesicles produced by the animal virus and those from the old stock, than was often observed between vaccinations made with the same stock—merely accidental, and dependent on peculiarities of individuals vaccinated.

Bearing in mind that Bousquet's drawings of the cowpox of Passy very nearly represent the effects of bovine vaccination, it will be easy to see how Dr. S. came to such a conclusion. His inspections of the vesicles were made on about the ninth day after insertion. Previous to that day the progress of *vaccinia* from animal virus is slow, and often would give an inexperienced observer the impression of less vigor and intensity than the vesicle resulting from the use of the old long-humanized virus. An examination of the plate will reveal the fact, that, up to the tenth day, the development of the vesicle, from the two sorts of virus, varies but very slightly. From that day till the 24th, in fact, till the fall of the crust, and even after, during life, in the infinite difference of the scar, the greatest possible variation is perceptible. Bousquet says:—

"We see that the new vaccine has a course at once more rapid and more deliberate than the old; more rapid in that it sooner gives signs of life; slower in that its duration is of so much longer continuance." "The resemblance is not greater at any time than on the seventh and eighth day; and, as it is at precisely that time that cases are inspected, it happened that the great difference between the two forms of *vaccinia* was apt to be overlooked. *Those who were satisfied with one such inspection could not comprehend that there was the slightest difference; and those who gave themselves the trouble to follow the vesicles to the end could still less comprehend how the difference could be denied or doubted.*"

"After the eighth day, the two viruses commence to differ very evidently from each other, and, as the disease they produce advances, the difference is more and more decided and clear. If we should regard the size of the vesicles alone, it would be impossible to be deceived. There is no exaggeration in saying that those from the new vaccine often acquire a size nearly double those from the other virus. . . . Not only have the new pustules the advantage in size; they are also flatter, more brilliant, more umbilicated, better defined, and firmer. This latter quality forms, in our opinion, one of their most remarkable

qualities. One forms a just idea of it, in collecting the virus, by the resistance to the instrument used in opening the vesicle. . . . It would seem that they are held to the skin by more numerous and closer attachments. As they develop, they elevate the skin and are raised above its surface; while the old pustules, more delicate and apparently more superficial, raise the epidermis merely, and appear more like an ordinary slight vesicle. . . . The areolar inflammation corresponds—in one case, intense, extended, phlegmonous; in the other, light, evanescent, erysipelatous. The difference here is more striking and apparent, because the two viruses, not following the same course, the areolæ do not exactly correspond. The areola of the old virus appears the earliest; that of the new virus follows at an interval of from one to two days. Thus it happens that a time arrives when, on one side, the inflammation is fading away, while, on the other, it exists in the greatest intensity.”

In drawing a parallel between the two forms of *vaccinia*, he says, of the cicatrix:—

## OLD.

“The scars, in general very superficial, make themselves evident, when the crust has fallen, rather by their reddish tint than by any depression left in the skin.

“At the end of some months, however, the eye can with difficulty, if at all, discover any cicatricial trace whatever.”

## NEW.

“To the crusts succeed large cicatrices, traversed by a multitude of little bands or bridles, which give them a reticulated appearance. Laying the finger in one of these a cavity is easily perceived, as if there had been a decided loss of substance” (and illustrating what I have said of the violence of cowpox lymph, and that of early human removes from the *original disease*).

“It is not uncommon for the crusts to leave after them suppurating wounds, ulcers, in fact, the cicatrization of which may be considerably delayed.

“I have seen pustules so deeply involving the skin that they produced absolute holes or pockets in it.”

For nearly two years after I became entirely satisfied of the superiority of animal virus, I continued to propagate the old long-humanized “stock” of the English Institution. I did so that I might afford physicians the means, by a very simple experiment, of comparing the old virus with the new. By vaccinating a few patients, even one, on one arm with one and on the other with the other virus, and carefully noting, every two or three days, the results, hundreds of physicians were first made aware of the vast difference between old and new virus, and could not escape a conviction of the superiority of the latter. I would recommend to doubters a repetition of the experiment. I do not know, however, where, in America, they can obtain virus of the necessary length of humanization; it is very doubtful if a particle exists on this side of the Atlantic of more than a few human removes from the “*cowpox of Beaugency*.”

## STATISTICS, ETC.

I would be glad to give in the statistical part of this report an accurate tabulation of the observation and results of other American animal vaccinators, but such data were not accessible to me.



With the exception of some quasi, "reports," circulated as business circulars and advertisements, evidently unreliable, I have seen literally nothing published in America. These I certainly shall not make use of. Even the names of most of the host of physicians and others who in the past few years have enterprised animal vaccination, are quite unknown to me. I could not communicate with them all, even if I were willing to make apparently impertinent inquiry of any, and if I should fail to address and quote all I should certainly be accused of partiality and unfairness. I prefer, therefore, to confine my statistical statements to the results of my own observations. Fortunately they have been amply sufficient. During the six years and nine months since I introduced animal vaccination, I have vaccinated and superintended the vaccination of 580 animals, besides some forty more in my early experiments. From these animals over 800,000 charged points, and an uncounted, but very large number of crusts and tubes of fluid lymph—many thousands—have been issued. This virus has been consumed by nearly 9000 physicians whose names are in my register, beside a very large number whose names are not recorded. I have supplied virus to vaccinate many cities and other municipalities, great and small, to a very large number, with quantities of from 500 to 84,000 points. Many of these have been supplied with aggregates of from 5000 to 15,000 points each. I have supplied the Departments of War and of the Interior with large quantities of virus, principally in the form of crusts, for the vaccination of troops, frontiersmen, and Indians, and in one instance supplied 3000 "points" for the arrest of a variolous epidemic which threatened the annihilation of an Icelandic colony in British America. I do not think that it would be possible to enjoy larger or more varied opportunities of this sort, nor do I believe the history of vaccination offers their parallel. Beside the correspondence of so many physicians, during the epidemic of 1872-3 I vaccinated and revaccinated very nearly 12,000 patients. Although I have endeavored to obtain from many of these sources, particularly from the large public vaccinations of cities, such as Boston, Washington, Erie, Lowell, Syracuse, and Fall River, something like detailed statistical returns, I have, except in rare instances, and those of individual practitioners, failed to receive any very exact and detailed document of this sort, but from hundreds, indeed thousands, I have received general statements of results. These, during the first four years

or thereabout, varied a great deal, a result undoubtedly of a want of knowledge on my part of the very best time for collecting, and on the part of my correspondents of the method of most successfully using the animal vaccine, the result of a want of knowledge of the same sort in myself. In the last three years, returns have been much more uniformly satisfactory, for now the best period for collecting and the best mode of employing the virus have been fully ascertained. During the first period frequent complaint was made of failure of primary vaccination of infants, while complaint of failure of primary vaccination of adults was not made by others or noticed by myself. This fact puzzled me a great deal, but its simple solution is that vaccination having been made, as was common with the old and more soluble human virus, by merely rubbing the charged surface of the point on the minute incisions on the arm, and depending on the exuded blood and serum to dissolve the dried virus, an amount of rubbing and manipulation was easily accomplished, and endured by the adult, which, for evident reasons, was not generally practicable on the timid, shrinking infant, generally in the arms of a watchful, sympathetic mother. The simple key and remedy of all the early disappointment was found in the variable vigor of virus, from error in collecting it; the great insolubility of bovine albumen and the consequent necessity of accomplishing its perfect solution before application to, and pressure *into*, the little wounds on the arm of the vaccinee. Even in those early times of trial, some of my correspondents reported admirable results, and it was my observation of the method of vaccination of one of these who almost invariably succeeded in primary vaccination of infants, that led me to the conviction that failure was the result of fault in the vaccinator, and not in the vaccine. This gentleman took about ten times as long to vaccinate a patient as myself; this time was spent in carefully and diligently rubbing the moistened surface of the point on the little wounds on the arm. In my own primary vaccination of infants, I observed, and acknowledged in a publication made in March, 1872, failure in twenty per cent. of my cases, but now a failure in primary vaccination of infants is a very uncommon event. From the very first the remarkable success of animal virus in revaccination was generally, indeed universally, noticed. In these cases, of course, all the patients were adults. It is not worth while to occupy your time and my own by details of the early experimental period of animal vaccination, but I will very

briefly state that results of primary vaccination with the new virus are now almost invariably successful in the practice of experienced vaccinators at the first attempt. And those cases of want of susceptibility to repeated attempts noticed rarely with the old, are of decidedly rarer occurrence with the new lymph. The results of the vaccination in all cases (*i.e.*, of those only vaccinated once before, but at various ages) is very exactly seventy-three per cent. at the first attempt. If those cases which fail to be affected at this first trial are twice more attempted the result is raised to a fraction over eighty per cent. It is very remarkable how often my returns give almost precisely these numbers. There is still a good deal of difference between the percentage returned as resulting from revaccination. I have no doubt that one cause of this is the excellence or inferiority of the primary vaccination. Another cause of difference is from the fact that one physician will report that as a vaccinal effect which another will reject. My own statistics include every case which was to my conviction a success, and as such I distinctly class every case in which the operation of vaccination is followed by a distinct interval of from twenty-four hours or less to seventy-two hours of freedom from all symptoms, and, after this period, certain appearances often very slight at points of insertion, and sometimes persisting for but a few hours. Such cases I consider as decidedly of vaccinal effect, and the numbers given of successful results of first revaccinations with both sorts of virus, thirty-five and a fraction over eighty are, the first exactly what I observed in making, with very long humanized virus over five thousand first revaccinations of soldiers in 1861, of which an exact account was kept, and the other very nearly the percentage of precisely similar cases resulting from the use of animal virus by myself in 1872-73. Although, of course, I thus include many very slight cases as indicating decidedly vaccinal and protective effect, still a very large proportion of those revaccinated with bovine lymph present very decided developments of the vesicle and areola, and in certainly over fifty per cent. the appearances very nearly approach the typical primary vesicle, and in over thirty per cent. only to be distinguished from such vesicles by the more rapid evolution and sequence of the phenomena of the disease. This is to be fully understood, that when the primary vaccination had any virtue at all, no matter how remote the date of its performance, the secondary vaccination will not, in any case,

*exactly* resemble a perfect primary development. If there is no other difference, there will be one in the length of duration; but in the vast proportion of cases there are other differences—a want of perfect formation of vesicle and areola, a lack of perfect evolution of disease. Exactly as *varioid* varies from *variola* in infinite degrees, just so does the *vaccinoid* of revaccination differ from the *vaccinia* of perfect primary vaccination. A certain portion of so-called “*authorities*” deny any value in revaccination, unless, what is extremely rare, it results in a perfect evolution of the disease *vaccinia*, precisely as in a perfect primary vaccination. All other cases they term spurious, “merely local,” etc. etc. It is hard to follow these writers, and harder to understand how they have arrived at many of their positive conclusions, this among them; I will not spend time with them, but venture to assert what I think is the opinion of the vast mass of reasonable men in our profession, that as an attack of varioid in a once-vaccinated patient is a perfect preventive against a second attack of that disease, so the imperfect *vaccinia*, the *vaccinoid* often seen in revaccination, affords its subject just the same security, viz., the security that a person having twice passed through smallpox has against a third attack. The extreme nonsense which has been poured forth by “fine” writers and lecturers on medicine about revaccination, local irritation, mere result of inoculation of animal matter, etc. etc., is sufficiently disproved by the absolute impossibility of inducing a repetition of the very slightest of the effects I have termed “*vaccinal*,” by again vaccinating the patient who has once in revaccination exhibited them. This I have verified many hundreds of times, and in my own person by at least fifty repetitions of the operation, specific, though slight, vaccinal effect having followed the first revaccination with the animal virus. I know how very imperfect is the statistical part of this report; I know what an infinite respect and awe the average physician has for complicated tables of figures, although he very seldom attempts to analyze them. They look profound and scientific, and like what they very often are *not*, a result of great labor. Those who are most familiar with them and their construction know how false and unreliable they often are. I could, from the material in my possession, have arranged very imposing tables of statistics; but to do so would involve a great amount of labor in examination and analysis of letters for which I have no time or inclination. No matter how elaborate and complicated

might be my tables, their value would depend entirely on my conscience and truth, and all the statements I have made are of facts thoroughly ascertained and truthfully stated. I have given results of one revaccination as seventy-three per cent. Dr. Warlomont gives as a result of extensive revaccination with animal virus in Belgium sixty-two per cent. I don't know whether this is a result of one attempt simply, but presume it is. Such differences are to be accounted for in the manner in which I have explained the different returns of American physicians. Some of my correspondents have made returns of over ninety per cent. of success in revaccination, one of ninety-four, and another of ninety-six per cent. Such returns, of course, would, if correct, indicate a very miserable performance of primary vaccination, or that it had been done in the earliest infancy. Just exactly as the first vaccination was perfect and typical, and was followed by a perfect typical scar, and as the patient was advanced in life when it was done, will the secondary vaccination, no matter how vigorous the virus employed, fail to be perfect or fail entirely. I feel sure if one hundred people, thirty years old, who had been vaccinated but once, and in the first year of life, should be revaccinated with perfect vigorous bovine lymph, that almost every one of them would give more or less decided, generally very decided, vaccinal results. An adult vaccinated once and in infancy is almost sure to "take" when revaccinated with perfect virus. A person, twenty-five years old, first and well vaccinated at five years or upwards, can hardly ever be revaccinated with a decided result. I could illustrate the truth of the doctrine, of the endurance of the protection of perfect first vaccination being in exact relation to the age at which it is performed, by almost innumerable instances and proofs. Although, like every other truth, it has been opposed and reviled—this is a truth, a very important one. In that remote time in the future, when the bases of medicine shall be fact and truth, the result of exact observation and honest induction, this fact will be one of the corner-stones of vaccination.

#### ALLEGED DISADVANTAGES OF ANIMAL VACCINATION.

I must, more briefly than I could wish, consider the alleged disadvantages, the advantages of animal vaccination, and the best means of rendering the latter available to the American profession and people. I will begin with the disadvantages which have been alleged against the new method.

(1) That the vaccinia induced by the use of animal virus is objectionably and even dangerously violent. This opinion is one founded, not on actual observation, but on the traditions of the vaccine disease as observed by the early writers. It is certainly incorrect. It is, in the positive experience of many thousand American physicians, that animal vaccination is no more intense than typically perfect vaccination should be, that it is infinitely less liable to be followed by troublesome and irregular *sequelæ* than that of long humanization, and that it has, most unexpectedly, but most undoubtedly, proved to be exempt from that miserable complication, the pest of vaccinators, erysipelas. So much that I have already written illustrates my opinions and experience on this point that I shall say no more here.

(2) That animal vaccination is liable to be the means of communicating other animal diseases than that it is intended to communicate. This is a bugbear founded on nothing, a revival of the innumerable absurdities which embittered the life of Jenner, and which have been so worthily and wittily, although somewhat coarsely, satirized in one of the best caricatures of the famous Gilray. A sufficient answer is that there is not an authentic record, hardly even an unauthentic one, of a single case of this sort in the whole history of vaccination. The only disease so transmitted has been a very trivial form of herpes circinnatus, of which I have published an account in the *London Medical Times and Gazette* for April 14th of the present year, and that can never occur when animals are selected and kept with any approach to ordinary care and propriety. This disease can be remedied at once by the simplest means, and, now that it is known, need not occur. It is proper, however, that it should be mentioned. It is more than probable that at least 5000 bovine animals have been vaccinated during the past seven years in America. Many of these have been most carelessly selected and improperly kept, but the opponents of animal vaccination will look in vain for any facts to support their dire threatenings and forebodings of disaster.

(3) That animal virus does not "take" easily. This was a real objection before the peculiarities of animal lymph were understood. Now that it is appreciated that bovine albumen is much less readily soluble than that from the human subject, and that, therefore, special and peculiar care is necessary to insure

the solution of animal virus before insertion, the objection does not longer exist, and need not longer occupy us.

(4) That it does not "keep" well. This objection was founded on the unfortunate fact that, in the early history of animal vaccination in Europe, fluid lymph in tubes was almost exclusively employed. Such lymph is unreliable within twenty-four hours after its collection. If you collect 100 tubes of animal virus, about 30 of them will prove efficient when you open them, whether in one day or one year; the rest will be inert. Why this is so I cannot explain, nor has any one else *really* done so; it is simply, as yet, an unexplained fact in science, and the proper deduction from it is—don't use tube virus from the animal. Dried animal virus on ivory or bone points or quill-slips keeps as well as any other, and so does this virus in the form of the dried vesicle or scab. I have received animal virus five times from Europe, and that which was on points has in each case proved efficient. Animal virus sent to California every day or two during last summer, to the amount of many thousand points, proved, so far as I know and believe, efficient, and much of it after being kept nearly three months in that warm climate without particular precaution. "Points" of animal virus sent to New Mexico, Constantinople, the West Indies, Peru, and lately to England, have invariably been used with success after arrival at those distant places. Illustrations of the fact that good animal virus may be kept, with ordinary care, for any reasonable length of time, could be multiplied almost indefinitely if necessary.

(5) Another objection has been alleged: that the vaccination of an animal even with the warm fluid, or, as it is technically called, "living" lymph, is an uncertain process, and with tube or dried lymph very likely indeed to fail. This is one of the strongest objections mentioned by Seaton, to the adoption by the British Government of animal vaccination as one of the means of lymph supply for the National Vaccine Institution. I have no doubt that the very numerous English experimenters who, within the past year, have failed to accomplish the vaccination of animals, entirely agree with Dr. Seaton. When I commenced the vaccination of animals I was much troubled by apprehensions of failure, and, in a few instances, *did* fail entirely. In many I failed to induce the development of the number of vesicles I desired. I soon found that it was necessary to select animals whose skin was in a good state, well nourished and vascular,

and to exhaust a good deal more time and labor to insure perfect success than I had at first thought necessary. Properly done, vaccination of animals with bovine virus may be said to be invariably successful, so very rare are the exceptions. Depaul claims invariable success, and so also does Chauveau in their very numerous vaccinations of animals with animal lymph. I think it may be said that a "stock" of animal vaccine in the hands of a competent propagator, is fully as secure from loss as one of humanized lymph. An important fact is, that while to obtain animal virus in the most efficient state for human vaccination, it should be collected at a certain and brief period of the vesicle, that taken at a much later stage of the eruption is found to be quite efficient for the vaccination of other animals. If, as is the best and also much the most expensive method, animals are vaccinated directly from each other with warm fluid virus, the operation can be done with more facility than if dried lymph is employed, but still very considerable time and diligence are requisite. When points or quills are used the labor is much greater, and more time is required to insure perfect solution of the virus. It must be acknowledged that the vaccination of animals and collection of virus require, for their best accomplishment, a very decided degree of technical skill, patience, and experience. With these, nothing can be more certain in its results, and failure of animal vaccination conducted by physicians of proper experience need not be feared. The great reasons why Seaton was led to consider the vaccination of animals a precarious process were, that in 1869, in Europe, tube lymph was almost exclusively employed, and when points were used they were of a very small size, and on this account were difficult to handle, and held too small an amount of virus. Neither was it then understood how necessary it was to take a good deal of time and care to dissolve the dried lymph and to effect its perfect insertion. To insure the best results in vaccinating animals, virus should be used very freely and with patient diligence; with these success is very certain.

(6) It may and has been objected that animal virus is expensive and difficult to obtain, and that its use will necessitate the devotion of certain persons to its propagation, from whom alone it can be obtained, while every primary vaccination, and as some maintain, almost every secondary one too, affords an abundant supply without any expense or trouble beyond the slight labor of col-



lecting it. This objection of expense will always undoubtedly exist, unless the Government, either national or of the respective States, each for its own people, should, as in England and elsewhere, assume the duty of supplying virus gratuitously. That this will even be done in the United States does not, in the light of past experience, seem very probable, and it is not likely that the objection alluded to will be removed. That it is a serious objection must be admitted, particularly in view of the utterly paltry fee generally paid for vaccination. If, however, the profession should do what always should have been done, demand a fee for vaccination, in some remote degree corresponding to the greatness of the benefit conferred, from those able to pay, while those pecuniarily unable should, for the public good and safety, be vaccinated at the public expense, the evil would cease to exist. If, as is now the case, a fee of from one dollar to even as low as one quarter of that sum is paid for vaccination by those amply able to pay a proper fee, while physicians are expected to vaccinate the poor gratuitously, it is not easy to see how physicians can afford to pay such a price for virus as will enable any competent person to devote himself to its production. The practice of the profession is absurdly lax. The wish of physicians to afford a great benefit has led to a disinclination to withhold it or to refuse to vaccinate, however insignificant the *honorarium* offered. Unfortunately, I think, the mere operation by which vaccination is performed is so simple that any one can do it, and men, practising medicine, more mindful of their own profit than the good of the profession, have made the discovery that a very industrious person may make good wages by vaccinating at twenty-five cents a head if his virus costs nothing. For the good not only of the profession, but of the public, a proper fee for vaccination should be demanded and insisted upon, and public vaccination should be done at the public expense. It is of the highest importance that vaccination of the whole community should be done in the best way. It is particularly necessary that the vast masses of the poor and laboring population should be fully protected. Among these classes, since the practice of vaccination has prevailed, has always been the citadel of smallpox, for reasons that are very evident and still exist in as much force as ever. The wealthy and easy classes are, as a rule, sufficiently and indeed often over vaccinated, simply because they are able to pay. When a good fee for a little scratching of a patient's

arm and for a subsequent visit or two rewards the medical attendant's eloquence, he can be very eloquent and convincing on the propriety and necessity of being vaccinated once in life, twice in life; and some gentlemen are so very fearful of danger that they vaccinate their affluent patients every time the faintest and most distant rumor of smallpox appears in the newspapers. For their own credit and business reputation, the physicians of the rich are very careful to ascertain the source of the virus they employ, and there is no reason to fear that the higher classes will fail to be vaccinated enough and often far more than enough. With the poor, however, and those who, though not poor, have been led to think, somehow, that a quarter the minimum fee for a single professional visit is quite sufficient remuneration for an operation, the proper performance of which necessitates two visits at least and often more, it is very different. The poor, those quite unable to pay, are supposed to be vaccinated at the expense of the various municipalities and by various medical charities, but it must be admitted that this public vaccination is generally, almost invariably, done in a very imperfect manner, for the very good reason that the payment made is wretchedly inadequate for the service supposed to be done, but, as in all such cases, not done properly. Those people who, though able to pay, have been allowed by the profession to believe that an utterly insignificant fee for vaccination is sufficient, very often, as is not unusual in such cases, cheat themselves. A vast deal of the vaccination of this class is done very badly indeed. Such people, vaccinated by men who infest every considerable community, for an utterly insufficient fee, are hardly ever inspected; any kind of a sore arm is held as proof positive of perfect vaccination, and very often the mystic rite is supposed to be consummated, although no trace whatever of sore or vaccinal cicatrix result. The result in the aggregate of (1) no government provision for maintaining the standard of vaccine excellence and for the free supply of virus; (2) of the ignorance and carelessness of practitioners in taking virus from improper *vaccinifers*, from vesicles at improper periods, and often by repeated tappings, and from traders without sufficient or any guarantee of excellence; (3) of performing vaccination for a fee which is in no wise a proper fee, nor one for which it is possible to do vaccination as it should be done and properly to inspect and verify the result; (4) of no sufficient or efficient appropriation or method for public vaccination, except in times of epidemic or panic, and of other

causes which might be stated—is that a very large proportion of the population of the United States has been very badly vaccinated or not vaccinated at all. The necessity for a very decided change and reform in the fee demanded for vaccination from a large part of the class of paying patients, and the thorough and constant vaccination of the non-paying class, not by the more and more overworked and underpaid doctor, but, for the protection of the public, at the public expense, is one familiar to you all, and demanding earnest and prompt attention. I need not further allude to it here. Under existing conditions, the expense of animal virus is an obstacle and a very efficient one to the full acceptance of a most important practice. The testimony of almost innumerable physicians, however, assures us that a very large proportion of the American population would rather pay five or ten times the extra expense of bovine virus than not have it employed in their cases. During the epidemic of 1872-3, the municipal authorities of Boston found it quite important to attempt to induce the people to submit to a general vaccination and revaccination with the old virus and had, very much against their will, to pay some \$20,000 for animal virus, which was used with the greatest success, and to the perfect acceptance of the population. If conducted in the only way that should meet with the approval of the profession, animal vaccination offers, as a result of the very fact that its product can only be furnished by special, properly paid propagators, very decided advantages over the old method. This I will endeavor to prove when I speak of the advantages of the new method.

#### ADVANTAGES OF ANIMAL VACCINATION.

(1) First among the advantages of the new method of vaccination is the induction by its means of a far more perfect development of *vaccinia* than follows the use of virus of long humanization. In previous parts of this report the peculiarities of the phenomena of typically perfect *vaccinia* have been described. Whatever may be our opinion of the degree and permanence of the protection afforded by long humanized vaccination, it can hardly be doubted that the nearer the intentionally induced disease approaches in its phenomena to that casually produced on the hands of the milkers which, as I have maintained, has alone been absolutely *proved* to be permanently protective, the safer

are we in assuming for it a like permanently protective influence, and it is most indubitable that the *vaccinia* from early human removes from the spontaneous disease much more nearly approaches that observed in these casual cases than does that from the use of virus of long human transmission. A long and most frequently repeated personal experience, to which may be added the testimony of a very great number of physicians with whom I have corresponded, justifies me in asserting that the *vaccinia* from bovine lymph exhibits the phenomena of the disease induced by virus of very early human removes from the cowpox, and that this disease has now been observed to be induced in America for nearly seven years with perfect uniformity, and after more than eleven years of artificial bovine transmission, without any of that tendency to change; a change which many physicians coincide with the people in believing to be associated with diminution of prophylactic efficacy; a change which we all must admit *may* be thus associated. It seems to me proved that the *vaccinia* from animal virus is more perfect, and we have a right to hope, if not to assume, that just in proportion as it more perfectly resembles the casual disease in its constant phenomena so far as we can observe them, so may it prove also to closely resemble it in that quality of perfect and permanent protection from variola, which Jenner alone proved the latter to possess. Fully admitting that absolute proof, that this sanguine hope is well founded, can only be obtained after the lapse of many years by the careful observation and analysis of the millions of vaccinations and revaccinations which have been made with the bovine lymph, and with very early human removes therefrom in America, Belgium, and elsewhere during the past eleven years;—admitting this and the propriety, in view of the many disappointing experiences in the history of vaccination, of not too eagerly or confidently assuming anything that is not positively proved, are we not justified in considering that the wonderful uniformity of the *vaccinia* which has now in over eleven years been induced by the use of bovine lymph, its constancy to its own type, and the nearness of that type to that of the development of disease, most surely proved to be perfect, as an absolute advantage.

Although my own convictions are very much in favor of the use of animal virus direct from the cow and no other, I am quite willing to admit that virus of one, or ten, or possibly twenty human removes from the animal, *may* be as protective, and that

the possible evils, as for instance, syphilitic or erysipelalous contamination of even a single human remove, are not very urgent, and may, in a very great degree, be avoided by scrupulous care and selection of *vaccinifers*. Admitting this modified form of animal vaccination, we must also of course admit—

(2) The advantage and necessity of an ability at will to renew a "stock" of vaccine by return to the animal, and this can only be had by the maintenance of one or more perfectly reliable "*services*" of animal vaccination.

(3) Even admitting the utter fallacy and absurdity of a great majority of the popular prejudices and theories touching the transmission of human diseases, cutaneous and other, by vaccination, it cannot be denied that they are capable of giving the practitioner a great deal of trouble and annoyance, and have very often seriously compromised professional reputation and standing, and more than once or twice entangled unfortunate physicians in suits for damages. If animal virus possessed no other advantage, if it were only equal in excellence to that we had so long exclusively used, the fact that when using it the physician can utterly disclaim, and deny any possibility of transmission of human diseases, would alone be a very decided reason for its employment. It is also no small gain for the physician who, from time to time, renews his "stock" of lymph by a draft on the bovine source that he can know and appeal to the entire human pedigree of the virus that he makes use of in any given case. I have always felt that physicians ran no slight risk and were apt, as has often been discovered, to be put in a very awkward position by their utter ignorance of the real source and history of virus obtained from some dispensary in the most squalid, degraded, and immoral purlieus of some great city, or from some druggist or instrument maker as ignorant of its true source and history as the physician to whom it is sold. It surely is not necessary to further dilate upon the advantage of obtaining lymph from a physician who has a reputation at stake, and who, if desired, will allow a very skeptical brother to see his virus collected from the animal prostrate on the operating table.

(4) True bovine lymph is certainly free from all possibility of syphilitic contamination. I do not wish to say one word to create a needless panic or sensation in regard to vaccinal syphilis. Some years since I went to the expense of having Mr. Hutchinson's admirable and quite unanswerable report reprinted or rather ste-

reotyped from the 54th volume of the *Medico-Chirurgical Transactions*. I have the plates, but have never used them from an after-thought that my republishing that very valuable paper might lay me open to such a charge. Here, however, it is proper to refer to this subject. Vaccine syphilis is a real danger, one which has been both much exaggerated and very much under-estimated. No candid person who has carefully studied the literature of the subject can deny the authentic record of a very large number of undoubted cases, nor can he entirely escape a very uncomfortable conviction that a very great many cases may have occurred that have never been reported. Nay, it is very certain that if a thousand cases were to occur in one of our great cities this year, a very large proportion of them, in the utter ignorance of a large part of the profession of the peculiar phenomena of the complication, would be overlooked and classified in that very large and convenient category, "bad arms from morbid condition of *vaccinee*." Of those which should be ascertained, the number reported would depend on the degree to which the observer preferred the diffusion of scientific knowledge to his popular reputation and professional income. I do not think that a very large proportion of the cases would be reported. It is not my intention to enter at all here into the vexed discussion of vaccinal syphilis. It is not very material to my end in this paper to prove that vaccinal syphilis is most indubitably of a frequency by no means indicated by the rarity of reports of cases in the medical journals. That it has ever occurred even once, that even if it had never occurred, its possible future occurrence from the use of one virus, and the impossibility of its occurrence from the use of another, is reason quite overwhelming in its conclusiveness for the adoption of the latter. Men who talk of the rarity of this fearful possibility of syphilitic contamination as a reason for disregarding a means for its perfect avoidance, who are so sure that from a vaccine vesicle nothing but pure vaccine virus can be drawn, who can select their vaccinifers with such unerring judgment as to entirely exclude the possibility of syphilitic complication, are very unsafe counsellors, and very poor and unreliable students of that profession of which some of them doubtless consider themselves most distinguished professors. The "twaddle" of this sort which has been uttered and written in regard to vaccine syphilis during the past ten years has been incalculable. If it at all indicates the deliberate judgment of any considerable part of the medical pro-

fession, it is very sad and very disgraceful. If our dilemma was either to abandon vaccination or to practise it notwithstanding a possibility of transmitting syphilis in the operation, I should not hesitate at all; I should continue vaccination, using every possible care to insure the purity of the virus I made use of; but there is no such dilemma. Vaccination can be done in the best possible manner with virus, to which no suspicion of syphilitic contamination can attach. To insist that the use of such virus, is on this account to be advised seems superfluous, to argue that it is so still more needless. To all who have doubt or but dim perceptions in regard to vaccine syphilis I would recommend not an exhaustive study of the subject, but a simple and single perusal of Mr. Hutchinson's admirable paper just referred to, in connection with which I may, as illustrative of the value and reliability of the boast of the officers of the English Vaccine Institution, that no case of vaccinal syphilis was ever "reported" as occurring from the use of the virus issued thence, refer to the fact that the fourteen *vaccinees* of Mr. Hutchinson's report were vaccinated from a *vaccinifer* carefully selected at one of the "stations" of the English vaccine institution. Eleven of these were infected by the syphilitic poison, ten had chancres on both arms, one on a single arm, and three escaped. Official testimony on this point is worse than worthless. Any man who has any experience of red-tape and red-tape methods can tell how probable it is that the employés of the English vaccine establishment would report to their superior officers cases which the latter are peculiarly desirous not to have reported.

It would be as easy, nearly, for a camel to enter a needle's eye as a case of vaccine syphilis to be reported in the returns of the medical officer to the Privy Council. In connection with the eleven cases of vaccinal syphilis, it is instructive to know, before Mr. Hutchinson had, with admirable perseverance and great labor, traced, examined, and recorded them all, that many, indeed most of them, were in the care of various practitioners who failed entirely to discover the true nature of these "bad arms," and would, quite probably, were it not for Mr. Hutchinson, be now quite ready to declare that they had never seen a case of vaccinal syphilis.

(5) A very great advantage of animal vaccination is in its ability to furnish large amounts of virus regularly, and at very short notice. The supply need only be limited by the demand.

All that is needed to this end is, of course, a multiplication of the animals vaccinated. A properly organized and maintained establishment is also necessary; one that has ample facilities for the accommodation of a sufficient herd of animals, and for keeping them separate from each other. The capacity of such an establishment to supply vast amounts of virus has been fully and repeatedly proved in this country during the past epidemic prevalence of variola. The incalculable importance of ample supplies of perfect virus, I need not insist upon. It is only in times of epidemic and consequent popular panic that the people become awake to the importance of the perfect protection afforded by thorough vaccination and revaccination alone. It is not only very important at such times to have at once the means for immediate safety, but also that advantage may be most fully taken to fully vaccinate the community while this very rare and fleeting perception of the value of vaccination prevails, with a view to the prevention of future epidemics. The wretched straits to which the profession and people may be reduced in times of small-pox excitement, when dependent on human vaccine, are familiar to us all. Even the National Vaccine Institution of England, by far the most efficient agent of Jennerian vaccination in existence, was not able to prevent a fearful and abiding "*vaccine famine*" during the late epidemic. Every issue of every medical journal of London, week after week, month after month, abounded with complaints, and, if the epidemic had not soon subsided, there is little doubt that animal vaccination would of necessity have been established in England, notwithstanding the obstinate and singularly unreasonable opposition of those government officials who there lay down the law on all matters connected with vaccination. As it was, a long stride was taken toward this most desirable end. The next epidemic, inevitable under existing management, ere long will, without a shadow of doubt, firmly and permanently establish bovine vaccination, even in that stronghold of medical conservatism and red-tape. During variolous epidemics every unfortunate human *vaccinifer* is drawn upon; every vesicle is tapped and drained, and tapped and drained again. All sorts of imperfect and spurious cases, and cases of revaccination have to contribute their quota, and it is not to be doubted that an immense amount of inferior and worthless "vaccination" results from the use of inferior, or worthless, or contaminated virus dur-



ing times of "vaccine famine." These facts bring us to another advantage of animal vaccination.

(6) That it permits the vaccine disease to be developed without interruption, by tapping the vesicle to obtain lymph. It was a maxim of Jenner that, to be protective, the vaccine disease should in no way be interfered with; but as this maxim was inconsistent with his early direction to induce one vesicle only, he countenanced the production of more, that virus might be taken from some, but that *one* always should be left untouched. This leaving one vesicle untapped was, formerly, a strict rule of vaccine practice, but every one knows that during vaccine famines, even of moderate severity, this rule is now utterly disregarded. Every vesicle, good, bad, and indifferent, is not only tapped and drained of its contents, but this process is often repeated, even more than once. If there is any force at all in Jenner's maxim, and I believe, most religiously, that it is one of absolute truth, it is sufficiently evident that a method which entirely dispenses with all interference with the results and course of vaccination must on that account, if no other, be invaluable. There are abundant statistics in the archives of vaccination to prove the diminished and lost efficacy of *vaccinia*, the vesicles of which have all been drained of their contents, either accidentally or by design, but I need not quote them, or any further proof of what is self-evident, the importance of non-interference with a vaccinated "arm."

(7) I have before alluded to the disadvantage of the expensiveness of animal vaccine. This is inevitable so long as the profession shall be dependent on private enterprise for its supply; for the expense, though, for a public gratuitous provision of lymph, very insignificant in proportion to the advantage to the community of an unlimited and free supply of virus, is very considerable, and, in addition to constant and large pecuniary expenditure, the propagation of animal virus involves incessant labor of far from an agreeable description, and to a degree which would very seriously interfere with profitable attention to medical practice. This is so much the case that I felt it to be a great relief to transfer my vaccine farm, and stables, and business, with all their responsibilities and profits, slender enough in ordinary seasons, to my son, who had long been my most faithful assistant and partner. All this labor and expenditure must, of course, be paid for, and, as a consequence, unless supplied by the government,

perfect animal virus will always be expensive. This drawback has, however, a redeeming point.

(8) It is of very great importance to the profession to be able to draw material for vaccination from a known responsible source to which all complaints of those vaccinated can be referred. This advantage has often been appreciated, and is so evident that knaves in the profession who never used a particle of animal virus, have found it very convenient to *lie*, and to assure complaining patients that they had been vaccinated with "virus from the heifer."

(9) The immunity of true bovine vaccination from erysipelas. When I first began to use the animal vaccine it was with fear and trembling, from my apprehension of undue violence, and, above all, of erysipelatous complication. The absolute absence of erysipelas as a complication of animal vaccination was, therefore, far from expected. The very large experience I have had personally, and through an army of correspondents, is indicated elsewhere. In all that experience, I have known but one case of erysipelas, and that appeared on the twenty-second day after insertion, as a direct result of an ineffectual but persistent attempt to remove a crust. One other case was reported to me by letter, in which erysipelas appeared on the left foot of a child an hour after being vaccinated on the right arm. Neither of these cases were known to me, and in fact had not occurred when I published a recent paper on this subject.<sup>1</sup> They are now, at the earliest opportunity, reported, although neither of them was really a case of true vaccine erysipelas. Even admitting that they were perfect cases of the sort, they would not invalidate the claim of immunity based on such an enormous aggregate of vaccinations as have been totally free from the slightest approach to such complication. I decidedly assert the immunity from erysipelas of true animal vaccination. Time and experience will prove or disprove the truth of the assertion.

(10) To those who prefer to use virus of early human removes from the animal, the perfection of the vesicle of animal vaccination, the longer period during which it yields fluid virus, and the uniformity with which a firm typical crust results, constitute decided advantages to one who propagates and collects his own virus.

<sup>1</sup> Boston Med. and Surg. Journ., Feb. 1, 1877. "A Few Words on Unfortunate Results of Vaccination."

There is more than a single other advantage of the animal vaccine, but to only one more shall I refer, and to that but briefly, although the most important, perhaps of all.

(11) The very large proportion of secondary or *re*-vaccinations in which the animal vaccine induces unmistakable vaccinal effect. I have previously attempted to give a comparison between the animal and Jennerian vaccine in this respect. Long as this report has been, a much longer one would be necessary to properly expatiate upon the importance and value of this quality of animal vaccine. I hardly intend to do more here than mention it, and leave my hearers to reflect upon the immense number of individuals revaccinated over and over again without effect, pronounced "insusceptible," and yet subsequently becoming subjects or victims of smallpox or varioloid. The number of such cases is legion. The number of those who, on revaccination with the old, very long humanized virus, [*not* that of early human removes], experience vaccinal effect may be stated, at the outside, at 35 per cent. The number of those revaccinated with equal care, and repetition with animal virus, and virus of very early human removes, I affirm to be a fraction over 80 per cent., a difference of 45 per cent.; and this 45 per cent. I firmly believe to approximately represent the number of those insensible to the enfeebled influence of long humanized virus, but sensible to the intense *contagium* of variola just in the same degree as sensible to the intense power of bovine virus and that of the very early human removes from it. The doctrine that just in proportion as a human being is liable to the effect of the inoculation of perfect vaccine, is he liable to the contagion of variola, scouted as it has been by the theorists who have so largely been the so-called "authorities" on vaccination, is true and just, founded on abundant and accessible evidence. When vaccination rests at last on a basis of fact and truth and honest induction, rather than of authority and dogma, this very important doctrine will be fully recognized. When speaking of the peculiarities of vaccination with bovine lymph, I have alluded at length to its invariable production, in primary cases, of a clear and characteristic scar. I merely mention this here as an additional and decided advantage. No amount of theoretic folly will convince sensible physicians that such a scar is not an evidence of the utmost value that vaccination has been properly performed.

HOW CAN ANIMAL VACCINATION BE MADE MORE AVAILABLE TO  
THE PROFESSION AND PEOPLE OF AMERICA?

An important question, one which has never as yet been seriously considered, or, if so considered, no practical results have as yet indicated its proper consideration, is the best manner of making the benefits of vaccination most fully and freely available to the people of the United States. European governments have given this question very constant attention, and although it would be easy to criticize much that has been done, there has been evidence of a constant desire on their parts to attain and maintain the highest possible standard of excellence of vaccine supply, and considerable, often large, appropriations have been made to supply the profession with vaccine virus gratuitously, and thus, and by liberal rewards and honors to the most enthusiastic and diligent vaccinators, to afford to the indigent classes protection from smallpox gratuitously, or for a merely nominal fee. It is not the purpose of this paper to discuss the different methods by which the various governments of Europe endeavor to accomplish this most desirable end, but to ascertain if it be possible for better methods to be adopted for affording the medical profession of this country a constant supply of vaccine lymph than those at present existing.

Soon after the introduction of vaccination into America feeble attempts were made in most of our larger municipalities to establish institutions for the vaccination of the poor gratuitously, but they had but a weak and brief existence, and the business of free vaccination in the larger cities has been, for many years, one of the departments of dispensary practice. In accordance with statute in several of the States, physicians are appointed in each municipality whose duty is vaccination of all who apply. Some of the States have appointed vaccine physicians, whose duties are to propagate vaccine virus, and to afford supplies in limited amounts to physicians throughout the State. I believe I have stated all the provisions which can, in any way, be called public or governmental for the encouragement and diffusion of the practice of vaccination. It must be admitted that they are very poor and insufficient. A great deal of money is, in the aggregate, expended by the municipal governments and very little accomplished, for the sum paid by each is utterly inadequate to the desired end. A large number of petty sinecures to be

filled by an equal number of equally petty political physicians exist, which, so far as the vaccination of the people is concerned, might as well have no existence. It may illustrate my meaning to state my knowledge of a certain city which, in the persons of successive political aspirants, enjoyed the services of a vaccinating physician for eleven years, during which time twenty-three vaccinations were made by that official, whose salary for eleven years was twenty-two hundred dollars. The office existed at all because the State law required it, and the city fulfilled the letter but evaded the spirit of the law by granting a salary of two hundred dollars annually for the supposed performance of duties, the proper performance of which would be poorly paid by five times that amount. As an inevitable and unavoidable consequence men were found to take the salary, draw that with becoming official dignity, and do just nothing to earn it. Until about twenty years ago, the profession throughout the United States depended for supplies of lymph, to enable them to commence or renew the propagation of virus, upon the dispensaries and city physicians, particularly in New York, Philadelphia, and Boston. How very precarious and unsatisfactory was even this limited and expensive supply, many of the older members of this Association are well aware. During the past twenty years some private physicians have paid constant attention to the propagation of vaccine lymph, and its distribution to the profession, and, in a few instances, have been able to do this to a much greater extent and more satisfactorily than was done before. The method of animal vaccination has afforded a means of propagating virus and of supplying it in large quantities. A great many physicians and others have undertaken the business, and, as a consequence, the supply of vaccine virus is now only limited by the demand; and the experience of the late widely diffused epidemic sufficiently proves that virus can be supplied in this way in any quantity that may be required, an advantage which, whether appreciated or not, is and has been of incalculable and inestimable importance and value. During the late epidemic a very large number of the cities, towns, and smaller municipalities throughout the Union, particularly in the older States, and more particularly in those States included in New England, made arrangements with physicians devoted to the specialty of animal vaccination for such supplies of lymph as were needed for the vaccination of their citizens, either directly from the animal, or

by means of virus propagated by resident physicians from these supplies. The choice was always nominally and generally really given to all to be vaccinated as they should prefer—direct from the heifer, or with virus of a greater or less degree of humanization. A very large majority preferred vaccination with bovine lymph; and, although evidence has reached me from many quarters that very great deception was often practised, and virus was called bovine which was not, still, from the enormous consumption of animal virus during the epidemic, there can be no doubt whatever that at least eighty per cent. of the vaccinations done in New England was with animal virus. If all who decidedly preferred to be vaccinated in this way had been dealt with *quite* fairly, there is no doubt that the percentage would have been larger. The instincts and wishes and prejudices, if you will, of the people were, and are, so entirely in favor of animal virus that it is extremely doubtful if it were not for deception in calling that bovine lymph which is many removes therefrom, and nice little fictitious theories that one remove is so much less violent as to be much to be preferred, if one person in a thousand would be vaccinated with virus of even a single human remove. If animal virus was furnished, as it should be, gratuitously to the profession, the pecuniary inducement to deceit and convenient theories would be removed, and, to the very great advantage of all, true animal vaccination would soon become universal. It cannot be doubted that if it were possible in this country to afford an unlimited supply of true animal virus gratuitously to the profession for every possible need and emergency, a great step would be thereby taken towards the realization of what has been called "Jenner's dream," viz., the annihilation of smallpox; a dream only because the possibilities of vaccination have never been universally or even generally appreciated, nor that universal and complete vaccination and revaccination ever done or half done, on the complete doing of which depends settling whether Jenner, and many more, were dreamers or not fools, or only with the great misfortune of not being as great fools as the mass of their contemporaries.

Whether Jenner was a dreamer or not, he would be one of the wildest and most incoherent sort, who should expect our government to support any plan by which the best possible vaccine virus should be freely distributed to every physician in the length and breadth of the Union, for the more perfect and absolute pro-

tection of the people from a pestilence, the constant recurrence of which is one of the greatest possible injuries to a nation. We indulge in no such day dreams, but simply ask if there is any feasible plan for facilitating the vaccination of the people by a more free and inexpensive distribution of the material for its performance.

There is but one plan to which I think it at all probable that our government, either National or State, would be likely to afford efficient aid to the end we desire. It is that at present adopted with great success by Belgium; a country in which it is notorious that things are done in the best way, at the smallest expense, with the rarest wisdom and deliberation, and with the most rigid economy.

I am indebted to a letter and pamphlet from M. Warlomont, the distinguished physician, who introduced animal vaccination into Belgium; to letters and a very interesting pamphlet of Dr. C. R. Drysdale, of London, and to Dr. Seaton's famous report, for an account of animal vaccination in Belgium. Interesting as is the history of the rise, progress, and distinguished success of the innovation in that country, I can only here very briefly sketch so much of this history as relates to the connection of the Belgian government with Dr. Warlomont's enterprise. Two months after Dr. Lanoix introduced in Paris the Neapolitan method of animal vaccination, it was introduced in Brussels by Dr. Warlomont, and carried on as a private enterprise. This was in January, 1865. In April following, the town of Brussels, under the advice of a local medical committee, voted an annual subsidy to Dr. Warlomont's institution, and the superior *Conseil d'Hygiene Publique* in its report of the same month recommended the government "to favor, by all means in its power, the foundation of an establishment where the cowpox could be propagated on heifers." The government of Belgium did not suddenly defer to the wishes of these medical authorities. It preferred to wait till Dr. Warlomont's experiment should have received the sanction of time, and, therefore, waited some year and a half in prudent expectation, leisurely studying the important question submitted to it. In the mean time, Dr. Marianus, chairman of a committee appointed to watch Dr. Warlomont's experiments, and Dr. Roumelaere, chairman of a committee of the *Société Royale des Sciences Médicales et Naturelles de Bruxelles*, reported favorably on the ability of animal vaccination to produce a very large quantity of the finest

vaccine lymph. On hearing these reports several provinces, such as West Flanders, Hainault, and Brahaut, encouraged Dr. Warlomont by liberal subscriptions. The Minister of the Interior of Belgium at last resolved to terminate the examination of the question, and by a dispatch, dated September, 1866, he requested the Academy of Medicine to report to him whether there was any necessity for regenerating vaccine, and, if so, in what way this could best be realized. A committee of the Academy, of which Dr. Vleminckx was chairman, was charged with examining the question, and Dr. Marianus, secretary of that committee, submitted the following conclusions to the Academy of Medicine: "The committee is of opinion that the following reply be sent to the Minister of the Interior: (1) The Academy has already recognized the utility, and even the necessity of renewing vaccine, and has not changed its opinion on this matter. (2) A really practical method of obtaining this renewal would consist in the extended application of animal vaccination, founded on the inoculation of spontaneous cowpox upon heifers, on which the products of this inoculation should be unceasingly kept up by the processes recently introduced into science." After also consulting the provincial councils of medical practitioners in Liege, Hainault, West Flanders, Brahaut, Namur, etc., and receiving affirmative answers from six of these medical bodies, the government of Belgium created what is now called the Vaccinal State Institute of Belgium in 1868. This institute has for its object: (1) The renewal of the vaccine lymph at present used by means of animal vaccination founded on the inoculation of spontaneous cowpox upon heifers, etc. (2) The limited gratuitous distribution of virus thus obtained. It is in the sole charge and direction of the distinguished physician who first established animal vaccination in Belgium, whose labor and success have been thus gracefully and honorably recognized and rewarded. It is not to be understood that the Belgian government has simply supplanted Dr. Warlomont, and established an institution of its own, employing Dr. Warlomont to manage it for a certain salary. The plan of the Belgian government is, in my estimation, much wiser than this. Dr. Warlomont continues his original institution, disposes of his virus, and vaccinates patients of the better classes, who choose to apply to him, for his own private emolument and reward. The government simply indorses his efforts, with the full accord and approval of the medical profession



of the nation, and as evidence of this permits him to call his institution "L'Institut Vaccinale de l'Etat," and, for certain services rendered to the public, grants him a moderate annual subsidy. I cannot imagine a better plan, or one more worthy of the imitation of our own State and National governments. The evils, and they are great ones, of institutions presided over by paid officials, who derive their entire emolument from the public treasury, are avoided. The government obtains all the essential advantages of such institutions when, as is very rarely the case, they are well managed, because it leaves with him who controls it the stimulus and incentive of an increase of income, reward, and public recognition and reputation, dependent on the thorough and acceptable manner in which the duties of his position are performed. And all this advantage to the public is secured by an expenditure which, however important to the recipient, is very moderate and even trivial in comparison to the great benefits received. All that Belgium has done for M. Warlomont and animal vaccination, our own National and State governments could do as well, and with as great advantage to the public, for animal vaccination in America, and such of the men who have labored for its establishment here as might be considered worthy of such honor and reward. Belgium has doubtless given M. Warlomont some piece or two of red or blue ribbon; and in his letter to me, he states that the day previous to writing, the Queen of England and several of her family were revaccinated from his institution. These are rewards and recognitions that we cannot hope for, powerful and pleasant undoubtedly, but we should have to dispense with them, and probably can manage to do so.

I need add nothing, for this Belgium plan seems precisely that most feasible in this country; a plan by which, with perfect care and deliberation, certain persons should be designated as particularly worthy to carry on a very important enterprise, by the State, advised by the united wisdom of that profession most fit and able to afford such advice. In addition to this valuable and honorable recognition, a small annual payment in money, not for favor or in the way of bounty, but in mere payment for valuable and necessary services rendered to the public.

When our political fathers commence seriously to think that some action on their part is possibly necessary, or would be becoming, with a view to something like a State encouragement and support of vaccination, it seems hardly possible that the course

pursued by Belgium can fail of attracting their attention, and, possibly, it may incite them one of these days to a similar course. It seems probable that we shall have to wait a good while for all this; till we have had a few more epidemics, and till the increase of our cities and the increased density and squalor of their population shall render such epidemics more and more mortal, and, above all, more and more destructive of business and commerce, and in this way injurious to the public resources.

While waiting for that dim, and probably distant, future, is there nothing else that can be done to help animal vaccination? I think that this Association could do much; much to encourage and reward those physicians who have worked very hard to develop this method in America, and in doing so subserve the highest and best interests of the medical profession and the people. This might be done much as has been done in Belgium. Let this Association appoint a committee of its members, men simply practising the general profession, and without any interest except as general practitioners in any method of vaccination, let this committee calmly and deliberately investigate the whole subject of animal vaccination, and also the manner in which it is carried on by various physicians. When this investigation has been fully made, let the committee report to this Association whether animal vaccination is worthy of its approval, and who are the men engaged in that laborious and expensive specialty who most deserve the patronage and encouragement of the profession. It may be said that all this is unnecessary, that animal vaccination has got on very well, so far, without assistance, and, indeed, in spite of very vile and malignant opposition; and plenty of good animal virus is to be had without this Association being troubled about the matter. This style of remark is very common and popular, but will hardly be that of a deliberative association of representatives of the medical profession. The intense commercial competition which physicians, who have most worthily and untiringly devoted themselves to animal vaccination, have had to meet with, is not by any means calculated to develop animal vaccination, or to make the best possible virus cheaper and more attainable. Its only effect will be to disgust the ablest men who have devoted their study, labor, and means to this specialty, drive them out of the business, and leave the field to those druggists and instrument makers whose facilities for advertising and trade are greatest, and in whose hands animal vaccina-

tion will only become a method by which vaccine virus can be produced with the least expenditure, and consequently at the greatest profit. Such a system, such competition, is not favorable to the best possible supply of vaccine virus; a thing a great deal too important for good and evil, to be left in any hands but those of physicians, and physicians, too, of peculiar fitness and special attainment. The utter indifference manifested by many physicians as to the source and excellence of virus so long as they can obtain a slight reduction of price is simply disgraceful; such indifference can only tend to a continuance of imperfect and inferior vaccination, and to the withdrawal of those men from the production of animal virus who are not willing to enter into a war of advertisements and circulars, but who have labored very hard and well in a far from inviting field, and deserve the recognition and help of the profession.

In concluding this report I would apologize for its length, and still more for its many imperfections. Long as it is, it is not of nearly the length necessary fully to discuss a most important and much neglected subject. The imperfections are of course the fruit of the author's want of ability partly, but possibly, too, of the great difficulties of treating so extended and important a topic. With all its imperfections on its head I offer it, with the sincere hope that it may lead to some action on your part which may lead eventually to important results in accomplishing, what many physicians consider of transcendent importance, viz., the firm establishment of true animal vaccination, and the widest and freest distribution of the best possible vaccine virus.