Report on an outbreak of mild smallpox in New South Wales in 1913, and the measures taken for its control / by W.G. Armstrong, J. Burton Cleland and E.W. Ferguson.

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REPORT

ON AN

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PART III.

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By

W. G. Armstrong, M.B., Ch.M. (Syd.), D.P.H, (Camb.), Senior Medical Officer of Health for New South Wales; J. Burton Cleland, M.D., Ch.M. (Syd.), Principal Microbiologist; and E. W. Ferguson, M.B., Ch.M. (Syd.), Assistant Microbiologist, Department of Public Health, New South Wales.

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Part III.

Outbreak of Mild Smallpox at Sydney, 1913.

By W. G. Armstrong, M.B., Ch.M. (Syd.), D.P.H. (Camb.), Senior Medical Officer of Health for New South Wales; J. Burton Cleland, M.D., Ch.M. (Syd.), Principal Microbiologist; and E. W. Ferguson, M.B., Ch.M. (Syd.), Assistant Microbiologist, Department of Public Health, N.S.W.

I. CLINICAL REPORT ON CASES, AND ADMINISTRATIVE MEASURES.

(W. G. Armstrong.)

The epidemic, which is the subject of this report, has been of an exceedingly mild type. The fact that among over 1,000 cases only one death occurred (that of a parturient woman suffering from smallpox, who died of collapse two and a half hours after childbirth) constitute it indeed almost a unique record in the way of smallpox epidemics. In certain other directions the symptoms observed varied so widely from the classical picture presented by smallpox that, at the beginning, it was considered the disease was varicella. Unfortunately the earliest cases were exceptionally mild, even when compared with the average of the whole epidemic, and the persons first affected were so slightly ill, and the eruptions experienced by them so scanty, that no medical man was consulted by them, and subsequent inquiries have led to the conclusion that smallpox must have been present in Sydney for at least six weeks, and affected an unknown number of persons, before the Department of Public Health had any knowledge of the presence of an unusual form of eruptive disease in the State.

On 30th May, 1913, the owner and manager of a factory for the manufacture of underclothing, situated in Chalmers-street, Sydney, and employing over 200 hands, chiefly girls, reported that a number of his employees had, during the months of April and May, suffered from unusual rashes which appeared to be infectious. A medical officer of the Department of Public Health visited the factory the same day and learned that between 20th April and the end of May, a number of young women employed in the factory had suffered with slight eruptions, for the most part on the face, but also extending to other parts of the body. In each case the appearance of the eruption had been preceded by an attack of so-called "influenza," in which the most prominent symptoms had been headache, vertigo, shivering, and general pains. In some of the cases there had been backache, and in a few there had also been some vomiting, usually slight. None of the girls affected had ever been vaccinated. The precedent illness, in all the cases, appeared to have been of a very mild type, and while some of the girls had stayed away from business for a few days, some had not considered it necessary to do so. Not more than two of the girls affected had consulted a medical practitioner, and in those cases they stated they had been told that there was nothing much the matter.

Further inquiries elicited that the first case in the factory had occurred on or about 25th April, at which date a girl, E.D., aged 22, had been attacked by "influenza." Three days later she had developed a "pimply" rash on the face. She had been absent from work for a week, and had returned to duty feeling well before the eruption appeared.

At first E.D. denied all knowledge of any possible source of infection for her illness, but later she stated to the manager of the factory, and subsequently to the writer of this report, that she was very friendly with a young man, B.E., who had been a steward on the steamship "Zealandia," and who had arrived in Sydney on 12th April from Vancouver, British Columbia. She saw him at his mother's house on the day of his arrival, and the following days, and he was then suffering from an eruption on his face.

The young man B.E., was afterwards seen and cross-questioned. He was aged 23, and was said to have been vaccinated in infancy, but showed no scars of the operation. He was, on 26th June, slightly marked on the forehead with six shallow depressed cicatrices, and with several smaller ones on the cheeks. On questioning, he gave the following information: He left Vancouver, British Columbia, in the "Zealandia" on 19th March, and arrived in Sydney on 12th April. The ship touched at Victoria (B.C.), Honolulu, Suva, and Auckland (New Zealand), and B.E. went ashore at all ports. While ashore at Suva on 4th April, he fell sick with severe headache, pains in the stomach, and great weakness (no vomiting), and was confined to his bunk for two and a half days after leaving Suva, but did not see the ship's surgeon. His illness, therefore, appeared sixteen days after leaving Vancouver. The day after leaving Auckland, *i.e.*, on 9th April his face "broke out" in pimples. The eruption was scanty, and was confined to the face, forehead, and back of the neck, and before it appeared he felt quite well. He considered that the rash was a crop of small boils, and it did not entirely disappear from his face until some days after his arrival in Sydney. No one else on board, so far as he knew, suffered from a similar condition. He admitted that he knew the girl E.D. well, and saw her several times after his arrival in Sydney. The subsequent history of this man, B.E., is best given at this point though somewhat out of logical sequence.

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On 3rd July he was vaccinated, seven days later there was no sign of a normal "take." The site of vaccination presented three small "mulberry" marks slightly raised above the skin without any sign of vesiculation and without any surrounding areola. There was no swelling or gland enlargement. However, on 16th July, thirteen days after vaccination, on re-examination he showed three large pocks with slightly brawny induration of the arm. The pocks were not similar in appearance to ordinary vaccination lesions, but resemble them to a certain extent and contained a clear yellowish lymph. There had been considerable delay in their appearance compared with the usual results of vaccination. As far as could be ascertained no other person than the girl E.D. who came into contact with B.E. suffered from smallpox.

Subsequently, however, it was ascertained that at least one other passenger by the "Zealandia" developed smallpox after leaving the boat. The passenger in question was a Mormon native missionary who left the "Zealandia" when she touched at Auckland, New Zealand, and who is reported by the Auckland District Health Officer to have developed the disease on 15th April—seven days after reaching Auckland. The Auckland District Health Officer considers that the Mormon in question introduced into New Zealand the outbreak of mild smallpox which was prevalent among the Maoris, and to a lesser degree among the white population in the North Island of New Zealand in the year 1913. The disease among the white population in New Zealand appears to have been characterised by the same mildness of type as marked the outbreak of smallpox in New South Wales, but among the Maoris it was more severe in its effects, and the New Zealand health authorities estimated that it caused fifty-five deaths among them.

On examination of the employees of the Chalmers-street factory, it was found that nearly all of the persons said to have been affected showed small stains, dried scales, and in a few instances very shallow depressed cicatrices upon some portion of their bodies. In one or two instances these had been fairly numerous, but in several cases the total number observed upon any one person did not amount to twenty, while in some there were fewer still. One girl, for instance, had three such marks on her chest, and one on one arm. Another had twelve on the face, three on the right arm, and one on the left arm. In some instances girls who had suffered from precisely similar symptoms, "influenza" to the others had recovered completely and the symptoms had not been followed by any eruption.

On being questioned, the girls described the rash as having appeared as "pimples" and having come out in crops, which continued to erupt from day to day over a period of from three or four days to a week. Most of the girls appeared to have been rather more affected on the face than elsewhere, but this was not always the case, and in some instances the face had escaped altogether.

Every girl affected by the eruption stated that after the attack of "influenza" and before the rash appeared she felt quite well and continued so, and had returned to work either immediately or as soon as she was "fit to be seen."

The factory itself was in a new building, excellently planned in regard to lighting, ventilation, and sanitation, and maintained in an exceedingly cleanly and orderly manner. Most of the employees were engaged in making undergarments with the aid of sewing-machines run by power.

On 31st May one of the girls (G.H.) employed at the Chalmers-street factory was admitted into the Coast Hospital, Little Bay, suffering from a copious rash on her face, body, and limbs. She had been seen by two medical practitioners, who diagnosed her illness as a severe form of chickenpox. On 31st May she was seen by medical officers of the Health Department in consultation with the hospital medical staff. Her temperature was then normal and she did not appear to be ill. She also was unvaccinated. The eruption in her case was more plentiful than in any of the other cases which had been examined, but the absence of any serious symptoms of constitutional illness, when weighed with the symptoms observed in the other cases that had occurred at the factory, led to the formation of the opinion by the medical officers that they were dealing with a form of chickenpox.

On the same day Dr. Rice of Granville notified to the Department of Public Health the occurrence of an unusual case of eruptive disease in a girl in Granville. Drs. Paton and Armstrong visited the locality and examined the patient the same evening. The following are the notes then made on her condition :—

R.C., aged 21, female, employed at a clothing factory in Kent-street, Sydney, as machinist: Patient in bed, temperature 98·8, tongue clean, moist. Does not appear ill, except that nose and face are rather swollen. Marked on face, trunk, and limbs with discrete vesicular and pustular eruption. Most copious on face and on back, next on chest and abdomen. Scanty on limbs. Fairly plentiful on scalp. One lesion of soft palate. Size of lesions varies greatly from pin head to split pea. Shape generally circular, but some vesicles oval. Globular in form. No umbilication, all lesions appear to be superficially situated and jut out directly from the skin. Very little if any induration of base. No perfectly clear watery looking vesicles. Lesions appear to be in all stages—some tense and globular, others shrivelled and lax.

History :—Illness first began on Friday, 23rd May. Considerable pain in sides, no headache, slight chilliness. First sign of rash on the 27th as a pimple on the side of the nose. Pimples continued to erupt on chest, back, face, and scalp during the 28th, 29th, and 30th, fresh crops appearing every day. Has not felt very ill at any time but has not slept well owing to severe itching of rash. Has never been vaccinated.

The illness was diagnosed as chicken pox.

At first no connection could be made out between the case just recorded and those which occurred in the Chalmers-street factory, although the symptoms from which R.G. suffered

suffered rather closely resembled those which occurred among the Chalmers-street girls. Some weeks later however it was discovered that R.G. had been on friendly terms with one of the affected girls in the lastnamed factory, and had probably been in her company about three weeks before she was herself attacked by the eruption. Sub-equently also R.G. when vaccinated did not react to the vaccine though she had never before been vaccinated, and two other persons vaccinated at the same time from the same tube of lymph developed the usual vaccine lesion.

On 18th June the Sydney Hospital authorities notified the Department that a very unusual form of eruption had occurred in a patient in that institution. The hospital was visited by a medical officer of the Department and the patient E.B. was seen there. She was covered with a copious rash which in its appearance and distribution showed many resemblances to smallpox. The patient was sent the next day to the Coast Hospital, and as a measure of precaution all the persons in the ward of the Sydney Hospital were vaccinated. This case was considered to be very suspicious of smallpox in spite of the fact that the patient, who was unvaccinated, showed very little constitutional disturbance. Doubt was also cast upon the accuracy of the diagnosis in the earlier cases. In order to obtain more conclusive evidence, six of the persons who had been effected by the illness at first believed to be chicken pox were persuaded on 18th and 19th of June to allow themselves to be vaccinated under control conditions; that is to say the patient and one or two other persons who had not been affected by the illness were in each case vaccinated from the same tube of lymph. By the evening of Monday, 23rd June, it had become apparent that in every instance the person who had suffered from the attack or supposed chicken pox had failed to respond to the vaccination, though all the "controls" showed signs of successful vaccination. Neither the "controls" nor the "patients" had ever previously been vaccinated.

On 24th June the Honorable the Premier was informed of the position, and of the strong suspicions which had arisen that smallpox was present in Sydney. Authority was obtained from him to seek the opinion and advice of two medical practitioners outside the Department, and Dr. Charles Reid, Chief Quarantine Officer for New South Wales, and Dr. Walter Hull, were invited and consented to examine the patients who were known to be suffering or to have suffered from the suspicious illness. After visiting the Coast Hospitals and the private homes of the patients these gentlemen reported on the result of their inquiry to a special meeting of the Board of Health on 25th June.

On hearing the opinions of its own officers and of the two expert practitioners abovementioned, the Board decided that while the symptoms in some of the cases were suspicious of smallpox, every precaution—such as isolation, &c.—should be used until further vaccination results could be obtained. This further evidence was accordingly sought for and on Tuesday, 1st July, the Department's officers submitted to the Board of Health further evidence that seven persons who had suffered from the suspicious disease did not react to vaccination, while control vaccinations were successful in each case The disease was accordingly proclaimed by the Board on that date to be smallpox.

Nature of the Disease.

The evidence as to the identity of the New South Wales epidemic with true smallpox may be briefly summarised as follows:—The symptomatology is essentially the same, only differing in intensity of the manifestations. The period of incubation was the same. Vaccination was found to protect against the Sydney disease and an attack of the disorder was protective on the other hand against vaccination. The liability to abortion among pregnant women and the infection of the fœtus, which are so characteristic of classical smallpox, were also observed in the epidemic in Sydney. The more severe cases were accompanied by the typical variolous odour and followed by the depressed scarring or pitting of the skin which is the usual sequela of classical smallpox. So far as one can speak at this present time, the pitting promises to be permanent.

All these characteristics except the lastnamed were entirely absent in the numerous cases of chicken pox which were under observation in Sydney during the smallpox epidemic. Chicken pox was unusually prevalent and unusually severe in Sydney during the year 1913. Over 3,000 cases of chicken pox were seen and diagnosed by the staff of the Health Department during the epidemic of smallpox, and with very few exceptions the experienced staff found no difficulty in differentiating between the two diseases. Many instances occurred of chicken pox among recently vaccinated persons, and on the other hand in many cases persons recovering or but lately recovered from chicken pox were successfully vaccinated during the months of the epidemic. These observations were in marked contrast to the facts in relation to the cases of smallpox.

The theory that the disease observed in Sydney was a hybrid, is unscientific, and will not bear examination for a moment. The behaviour of the two diseases towards vaccination entirely negatives any such supposition.

Smallpox, like all other diseases, has varied in intensity in different outbreaks. Mild outbreaks have been observed from very early time. Sydenham states that "smallpox has its peculiar kinds which take one form during one series of years, and another during another." Jenner himself records an outbreak in which the virulence was surprisingly low. He says "it was of so mild a nature that a fatal instance was hardly ever heard of, and consequently so little dreaded by the lower orders, that they scrupled not to hold the same intercourse with each other as if no infectious disease had been present among them," and Van Swieten, in 1759, describes an outbreak which was "so mild that secondary fever is not manifested, and constantly is wanting, convalescence coming on on the eighth day of the eruption"

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To come to more recent times, during 1896 a very mild type of smallpox began to prevail in the south of the United States, and gradually spread over the whole country, and into Canada. In 1902 it invaded the island of Trinidad, and 5,154 cases were reported with but twenty-eight deaths. In 1911 Chapin records that 3,294 cases occurred in North Carolina without a single death. The same writer states that it is highly probable that the mild form of smallpox observed in England during 1901 and 1902 was introduced from America. Chapin further states that while this atypical form of smallpox was spreading in America, the classical and more severe form appeared from time to time in various places. Both forms always appeared to "breed true," but he adds that "health officers and clinicians all over the country who have had an extensive experience of the old type of the disease, as well as with the other forms, are convinced of their identity. The reasons are the same period of incubation, the characteristic though mild prodromal symptoms, the development of the eruption at the normal time, the distribution of the eruption, and its perfectly characteristic appearance in most cases. The crucial test of the identity of the two forms is, however, to be found in their immunity relation. Persons who have had smallpox, or who have been successfully vaccinated, are at least as immune to the mild as to the severe type. It is also found that persons who have had the mild type are equally immune to vaccinia."

After having swept through the United States, this mild type of smallpox invaded Canada, in parts of which it still persists. Official records show that it actually prevailed in British Columbia during the early months of 1913, and therefore at the time of the departure of the steamer "Zealandia" for Sydney with the steward B.E. on board.

The diagnosis of the mild type of smallpox, like that of the severer form, depends upon (1) the distribution of the focal rash; (2) the characters of the focal lesion; and (3) the onset of the illness and its relation to the appearance of the rash.

The Distribution of the Rash.—The modern method of diagnosing smallpox gives precedence to the distribution of the rash above all other evidence. In former times it was the accepted teaching to regard as more important the form or anatomical characters of the individual lesion. To quote Ricketts—"The evidence from position, there can be little doubt, is in most cases more intrinsically valuable than the evidence from character; it is certainly the more easily observed, and the more generally dependable." The broad features of the distribution of the rash in the classical picture of smallpox, are that the rash prefers the upper half of the body to the lower, that it is a rash of the face and arms rather than of the trunk and legs; that it affects the distal rather than the proximal ends of the limbs, the back of the trunk rather than the front, the extensor surfaces rather than the flexor. It prefers in fact, those surfaces which are most liable to irritation.

These broad features applied generally in the Sydney epidemic, and were on the whole relied on by us as the most important evidence presented to us in diagnosing a case. In individual instances anomalies of distribution did occur, and were sometimes marked, but these anomalies could generally be explained and allowed for if one did not forget the effects which precedent irritation of the skin always has upon the rash of smallpox. In several cases, among pregnant women for instance, the rash appeared first upon the abdomen and continued unusually plentiful there throughout the period of efflorescence. This was due to the friction of the clothing upon the distended and prominent surface of a part of the body which usually escapes very lightly from the focal rash of smallpox.

In many of the cases of smallpox seen in the New South Wales epidemic, the numerical severity of the rash was so low that all the pocks on the whole surface of the body numbered less than twenty, and even in some cases as few as three or four. In such cases it is impossible to expect the distribution of the rash to comply with any law. Nevertheless, when taken broadly, the rash of mild smallpox as a whole does follow the laws of distribution observed by the classical type of the disease, and with surprising accuracy. In a doubtful case one has sometimes adopted the expedient suggested by Wanklyn, of plotting out a plan of the rash upon one of those diagrams of the human figure which are sold by medical booksellers for recording physical signs, and this was always very helpful in obtaining a clear impression of the distribution of the rash, and a considerable aid in diagnosis. Usually in the milder cases of the epidemic the rash first appeared as a pimple on the nose or forehead, and in the majority of cases the rash on the face continued throughout efflorescence to exhibit greater numerical intensity than on any other part of the body. Nevertheless, instances were not wanting throughout the epidemic in which the face escaped altogether; but these were rare. Next to the face, the eruption effected the extensor surfaces of the forearms, then the back (especially between the shoulders), next the buttocks and thighs. The chest, and still more the abdomen, was almost invariably relatively and often entirely free from rash. This, of course, constituted a very useful diagnostic stigma in differentiating the disease from chicken-pox. The scalp and the male and female genital organs (the penis and vulva) were very frequently invaded. In all the more severe cases, the palms of the hands and soles of the feet were attacked, but in the milder cases they often escaped altogether. In the more severe forms of the diseases the formation of the pocks beneath the thick skin of the soles was often attended by a great deal of pain, and these pocks usually became inspissated and formed brown seed-like bodies, which had to be dug out with a knife on convalescence.

Although the eruption was usually scanty and sparse in the type of smallpox seen in Sydney, it was not always so. Instances in which the rash was confluent on the face and arms occurred, and not rarely a semiconfluent rash in those situations was observed.

In one patient, in which the pocks were counted, they numbered over 4,000 upon the whole surface of the body, of which 362 were upon the face. In another instance there were over 900 counted upon the face alone. In the latter case nearly all the pocks were small and badly developed. These cases were exceptional, however, and the average number of lesions upon the face in the majority of instances ranged from about twelve to, say, thirty or more.

The Individual Lesion. — The focal lesion in the Sydney epidemic manifested great variations both in its anatomical characteristics and in its development. In a small minority of the severer cases it approximated in both directions very closely to that of the classical type of smallpox. In such cases the rash appeared in a single crop, the lesion passed through the regular stages of papule, vesicle, and pustule, and the whole evolution, from the first appearance of the papule to the beginning of incrustation, occupied about eight days. The vesicles in these rare cases were circular, flat-topped or umbilicated, greyish in colour, and when pricked or incised the contents were not wholly discharged, indicating loculation of the vesicle.

In the overwhelming majority of our cases, however, the regular states of development of the lesion were obliterated, or nearly so, and the whole period of evolution was much shortened. Often the first sign of the rash was an outcrop of pimples on the nose or forehead, which acquired pustular heads within a few hours; and sometimes the changes were so rapid that the lesions seemed almost to make their first appearance as pustules. They exhibited a strong tendency to appear in crops, which continued to erupt from day to day throughout the whole period of efflorescence until the earlier lesions had dried up or become scabbed over. As a consequence, lesions were generally present at the same time on the same part of the body in various stages of development—a state of matters which is not generally distinctive of smallpox.

Another direction in which the eruption in our epidemic was aberrant was in the large proportion of small and abortive lesions. In most cases of the classical variety of smallpox a minority of the lesions are small and abortive, but in the New South Wales epidemic such abortive lesions were often in the immense majority.

Most of the variations from the classical type observed in our epidemic appeared to depend very largely upon the superficial character of the lesions. This characteristic showed itself best in the absence of pitting of the skin after recovery, which was seen in most of the cases, and in the shallowness of the little ulcers which were seen when a pustule was accidentally ruptured (about 10 per cent. of the patients, however, did show marked pitting). When the lesions were fairly large their superficial character was also shown by the appearance of the margin of the pustule. In chicken-pox the pustule or vesicle often appears to be lying upon the surface of the skin, in ordinary smallpox it juts through the skin, throwing the surrounding skin up in a slope round the base of the pustule. In this form of smallpox the appearance presented by a full-sized lesion is halfway between the two. It is less superficial than in chicken-pox, and more so than in ordinary smallpox. The same fact accounts for the sinuous, jagged outline and oval shape of the lesions which were often seen in the Sydney epidemic, especially those lesions situated on the trunk.

The clear watery pock which collapses easily on pressure with the finger-nail, with escape of its watery contents, which is nearly always present in some stage of an attack of chicken-pox, is never seen in mild smallpox. The presence of even one or two of these watery pocks in an eruption which might otherwise be regarded as suspicious, is always sufficient to clinch the diagnosis as against smallpox. Some other characteristics of the focal lesions, such as shape, irregularity of outline, and the appearance of the rash in successive crops, have no great value in the diagnosis of the disease.

It was the relative or complete absence of the eruptive fever which accounted for the exceeding mildness of the epidemic. Even in cases which passed as severe the maturation of the pustules was accompanied with very little elevation of temperature. In the case of the girl E.B., who was admitted into the Sydney Hospital, and whose illness in many respects was more typical of the ordinary form of smallpox than almost any other case seen in the epidemic, she never had a temperature to speak of after the rash appeared. She was admitted into the hospital on 12th June, and the rash first appeared on the 15th. Previous to the appearance of the rash she had a toxæmic fever running very near 105 degrees F., but after the rash had once appeared her temperature only once touched 101 degrees F., and that was on 20th June, the day after her removal to the Coast Hospital. On the 21st it fell to 99 degrees F., and on the 22nd to normal, from which it never rose again. All through the stage of pustulation she stated that she felt perfectly well, and complained of not getting enough meat to eat.

In most of the cases sent to quarantine the temperature continued normal throughout ths eruptive stage, and the patients did not exhibit any symptoms of that profound illness which usually accompanies pustulation in the unvaccinated.

The Invasion Period.—The mode of onset of the illness—the third member of the diagnostic trinity enumerated—would be of greater value if human testimony were more reliable. Patients and their friends so often deliberately suppressed the truth, or, for some reason, made false statements, that this class of evidence always had to be received with great caution. When reliable, such evidence was of great value in diagnosis, and formed a diagnostic barrier between this degraded type of smallpox and the other diseases which it most resembles—chicken pox.

It is usually rather gradual in its onset, and is marked by frontal headache (which, according to the statement of patients, is always the most prominent symptom), general febrile symptoms, backache (in about 20 per cent. of the cases), vague general pains, vertigo, rarely distinct rigors, and sometimes vomiting. Patients almost always liken

liken the attack to one of influenza. The invasion period varies from one to ten days, and averages about five days, and during this time the toxæmic fever may run rather high. One had naturally very few opportunities of observing the disease at this stage; but in instances of the more severe cases which one has personally seen, and in others upon which the testimony of other medical practitioners has been forthcoming, the temperature in the invasion stage has mounted well above 103 degrees F., and sometimes reached 105 degrees F.

All the symptoms of the period of invasion usually remit for a variable time before the rash appears, and the patient considers himself quite well and generally returns to work, if the illness has been sufficiently severe to compel him to cease work at all. For, in some of the milder cases, the severity of the symptoms is not sufficient to cause cessation of regular occupation. In some cases the symptoms of the invasion period do not abate until the rash appears; but this seems to be unusual. Speaking generally, the period of invasion is longer than in the classical type of the disease. Judging from the cases in which young children have been affected in this epidemic, the symptoms of invasion have been less marked in them than in adults. Very frequently the mothers of young children who were attacked stated that the child merely appeared to be a little out of sorts for two or three days before the appearance of the rash, and sometimes even this symptom was wanting, or was of so slight a nature as to be overlooked by the mother.

Smallpox without Eruption. Many of the profession are inclined to regard the condition so described as apocryphal. But in this epidemic there have been several instances observed of what appeared to be attacks of smallpox without a rash. In two cases at least there has been what might fairly be considered absolute proof. In both instances the subjects were young women employed in a factory in which there had been several cases of smallpox, and residing in districts in which at that time there was no smallpox; neither had ever previously been vaccinated. Both suffered in a characteristic way from the symptoms of invasion of smallpox, and remained away from work as invalids at home. Both recovered and were not afterwards the subjects of any rash. But at periods of seventeen and eighteen days after the onsets of their respective attacks other persons in their households became affected by the symptoms of invasion, and the persons so secondarily affected after recovering from the symptoms of invasion developed mild smallpox eruptions. Both the girls originally attacked were vaccinated subsequently on two occasions and in both cases unsuccessfully.

Influence of the Disease on Pregnancy.

Twenty-one pregnant women are known to have been attacked. Seven of them were prematurely confined and three were confined at full term, the attack of smallpox having occurred at or just before the time they were expecting confinement. In the remaining eleven cases no miscarriage nor symptoms of threatened miscarriage had occurred up to the time of complete recovery and discharge from the Quarantine Station. In four cases it was subsequently ascertained that the mother was confined at full term of a living child. In the other seven cases the mother was lost sight of.

The periods of pregnancy reached by those mothers who were prematurely confined were as follows:—One at three months; two at four months; one at five months; one at six months; two at eight months. All the mothers prematurely confined subsequently did well.

Two only of the prematurely born children showed a smallpox rash. In both instances the confinement took place after complete recovery of the mother and her return to her home from the Quarantine Station. Both these cases present points of some interest.

Mrs. B., aged 27 (case No. 234), contracted smallpox when five and a half months pregnant and was removed to quarantine. She had a severe attack (as severity counted in this epidemic). Two days after returning home—she was then six months and three weeks pregnant—she was delivered of twins, both born alive. One child presented the remains of a copious smallpox rash. Most of the lesions had dried up and were represented by stains, but a few still had scales on, and some were deeply pitted. This child lived three weeks. The other twin, who was entirely unmarked, died in twelve hours. Dr. C. H. E. Lawes, of Petersham, who attended the mother in her confinement and reported the case, was of opinion that prematurity was the cause of death of both children.

Mrs. W., aged 34, multipara (case 948), was attacked by smallpox when three months pregnant, and was removed to quarantine. She had a mild attack, and returned home twenty-five days later quite recovered. Six days after her return to her home she was confined of a dead fœtus marked by smallpox. No softening or maceration of the child's tissues had occurred, but the skin was slightly detached on one of the legs. Scattered over the face, scalp, back, forearms, palms, and soles were numerous circular, or oval, white spots which had a cicatricial appearance, but were not depressed or puckered. Dr. Cuthbert Hall, of Parramatta, attended the mother in her confinement, and was of opinion that the death of the fœtus was due to smallpox. Both parents were perfectly healthy, and the mother had had five previous full time confinement and no miscarriage.

Of the other premature confinements, one—at three months—occurred thirty days after the first appearance of the smallpox rash in the mother; one—at four months—twenty days after the rash; one—at eight months—two days after the mother was attacked by the symptoms of onset, but before the appearance of the rash; one—at eight months—occurred the day after the appearance of the rash; and one—at five months—twenty-three days after the appearance of the rash.

Regarding

Regarding the three cases in which pregnant women suffering from smallpox were confined at full term:—one mother was attacked by smallpox two days before the birth of the child, but the rash did not show itself on the mother until two days after her confinement; in a second case the mother was confined twelve days after she developed the eruption. In both the above cases the child was successfully vaccinated within forty-eight hours of birth and entirely escaped infection.

The third case was that of the only death which was attributed to smallpox. The patient was a multipara, aged 29 (case 598). She suffered from a severe attack, the rash being nearly confluent on the forehead and face, and very profuse elsewhere. The eruption appeared on 25th August, and she was confined of a full time male child on 29th August. The child was born at 12.30 p.m. without any complications. At 12·50, the placenta being partly in the vagina, expression was attempted without success; hæmorrhage was slight. At 1·20 p.m. the patient suddenly collapsed, and owing to the bleeding becoming severe, the gloved hand was inserted into the uterus and the contents removed, and the uterus induced to contract firmly, adrenalin and ergot were given and the patient's condition improved. A little later she again collapsed, and in spite of restorative measures, died at 3 p.m. The bleeding, though severe, was not considered by Dr. E. M. Robertson (the Medical Officer in charge of the Quarantine Hospital) who attended the patient, to be sufficient to cause death. A post-mortem examination did not disclose any cause of death, and Dr. Robertson considered that the collapse and death were due to the depressing effects of the disease from which she was suffering.

Prodromal Rashes.

In this epidemic prodromal rashes appear to have been of very rare occurrence. Nothing that could have been considered a prodromal rash was ever observed by any officer of this Department, nor was any evidence of the occurrence of such a rash obtained from patients or their friends.

Progress of the Epidemic.

Sydney, and 28 localities outside of the Metropolitan District were affected. Many of the persons affected in country places acquired infection in Sydney, and were attacked a few days later after reaching their homes in the country. Cases were removed from nearly all parts of the metropolitan area.

Table showing number of cases occurring in the Metropolitan District from beginning of outbreak to 31st December, 1913.

Municipalities—		Municipalities—*continued*—	
City of Sydney:		Leichhardt	27
Central City	24	Lidcombe	1
Blackfriars	5	Manly	2
Camperdown	12	Marrickville	21
Centennial Park	2	Mascot	19
Chippendale	30	Mosman	7
Darlinghurst	7	Newtown	41
Moore Park	1	North Sydney	13
Pyrmont	20	Paddington	51
Surry Hills	75	Parramatta	15
Ultimo	17	Petersham	9
Woolloomooloo	30	Randwick	18
	223	Redfern	61
Alexandria	58	Rockdale	11
Annandale	16	Ryde	1
Ashfield	17	Strathfield	8
Auburn	9	St. Peter's	16
Balmain	29	Waterloo	81
Bankstown	1	Waverley	28
Bexley	9	Willoughby	7
Botany	1	Woollahra	15
Burwood	3		1,012
Canterbury	17	Shires—	
Concord	1	Kurringai Shire	2
Drummoyne	3	Warringah Shire	1
Epping	1		3
Erskineville	54		1,015
Glebe	62		
Granville	28		
Hunter's Hill	1	Country cases (see following table)	58
Hurstville	19		1,073
Kogarah	8		

Table showing number of cases occurring in country districts:—

Albury	1	Illabo	1	Nyngan	2
Adelong	4	Katoomba	1	Orange	2
Bourke	1	Kempsey	1	Parkes	1
Cawley	1	Lithgow	3	Peak Hill	1
Coolah	8	Liverpool	2	Penrith	2
Cootamundra	6	Maclean	5	Temora	4
Goulburn	1	Mt. Kosciusko	1	Taree	1
Grafton	1	Narrabri	1	Tumut	2
Grenfell	1	Newcastle	1	Ulmarra	2
Harden	1				58

Table

TABLE showing number of attacks under Sexes and Age Groups.

Age Group.	—1		—5		—10		—20		—30		—40		—50		—60		Over 60		Total.	
Sex.	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Attacks ...	7	21	16	30	46	43	129	132	237	175	86	51	33	28	16	12	6	5	576	497

Sex Incidence.—The disease attacked 576 males and 497 females. The preponderance of males attacked over females is in accordance with observations on the sex incidence of smallpox in other countries. It was observed in all stages of the epidemic except the earliest. More females than males were attacked in that stage owing doubtless to the fact that the epidemic first appeared and spread in a large factory employing only female hands. It will be observed that at ages under five years there was a great preponderance of females among those attacked.

Age Incidence.—The observed incidence was on ages from two days to eighty-two years. Six children were attacked at ages under three months and seven persons at ages over sixty-five years. Nearly four-fifths of all attacks occured at ages between ten years and forty years, while less than one-sixth occurred among children under 10 years of age. One living child was born with a smallpox eruption.

TABLE showing the number of attacks recorded during each week :—

Cases recorded to July 5th			111	Cases recorded in week ending		October 11th	23
,,	,,	week ending July 12th.....	94	,,	,,	October 18th	32
,,	,,	,, July 19th.....	93	,,	,,	October 25th	32
,,	,,	,, July 26th.....	49	,,	,,	November 1st	17
,,	,,	,, August 2nd.....	61	,,	,,	November 8th	18
,,	,,	,, August 9th	42	,,	,,	November 15th	18
,,	,,	,, August 16th ...	40	,,	,,	November 22nd	7
,,	,,	,, August 23rd ...	85	,,	,,	November 29th	13
,,	,,	,, August 30th ...	59	,,	,,	December 6th..	24
,,	,,	,, September 6th..	67	,,	,,	December 13th	5
,,	,,	,, September 13th	59	,,	,,	December 20th	8
,,	,,	,, September 20th	46	,,	,,	December 27th	2
,,	,,	,, September 27th	30	,,	,,	December 27th–31st	2
,,	,,	,, October 4th.....	36				
							1,073

The cases recorded up to 5th July included all those earlier cases which were considered in the first place to be varicella. Many of them only came within the purview of the Department after complete convalescence had been established, and no further action in the direction of segregation appeared to be necessary. A number of cases which were investigated by the Department, and in the light of subsequent events, were judged to have been smallpox are included.

The epidemic showed no signs of abatement throughout July, August, and September. At the end of the latter month a steady decline in the number of recorded cases set in and continued until the end of the year. The decline in the weekly totals of new cases was synchronous with the onset of warmer weather.

With the exception of the earliest cases of the epidemic, which, as has already been stated, were exceptionally mild, no variation in the severity of the type of the disease was noted. Throughout the epidemic the great majority of the attacks were of a very mild type, but the proportion of cases of semiconfluent and copious eruptions remained about the same at the end of the year when the number of cases was small as at the height of the epidemic.

ADMINISTRATIVE MEASURES.

The epidemic was formally declared to be smallpox at a meeting of the Board of Health on 1st July, 1913, mainly on the evidence submitted by the Senior Medical Officer of Health (Dr. W. G. Armstrong) that thirteen persons who had recovered from the suspected disease had failed to react to vaccination, although never previously vaccinated, while in each case other persons who had not suffered from the disease, and who had been vaccinated from the same tube of lymph, had developed normal vaccinal reactions. Directions were given that steps should be taken for the treatment of patients at the Quarantine Station, North Head, and for isolation of contacts. It was also directed that vaccination should be offered to the public free of charge; that premises on which cases had occurred should be disinfected; and that the Premier of the State should be informed of all the circumstances with a view to publicity being given to the outbreak in the Press. Steps were immediately taken to give effect to these directions.

On 2nd July the Director-General of Public Health (Dr. R. T. Paton) made arrangements with the Federal Director of Quarantine whereby the New South Wales Department of Public Health undertook temporarily to provide the medical and nursing staff required for attendance on patients at the Quarantine Station, but the Station remained in the control of the Commonwealth Government under the general supervision of Dr. C. W. Reid, Chief Quarantine Officer of New South Wales.

Dr. F. M. Suckling, Assistant Medical Officer of the New South Wales Government, was placed in medical charge of the Quarantine Hospital, assisted by a nursing staff detailed from the Coast Hospital. A fortnight later Dr. Suckling was relieved by Dr. G. A. M. Heydon, one of the assistant medical officers of the Coast Hospital.

On

On 25th August the Commonwealth Quarantine Department took over the whole control of the Quarantine Hospital, and the Coast Hospital nursing staff was withdrawn on that date.

All patients known to be suffering from smallpox were conveyed by steam launch from Woolloomooloo Bay to the Quarantine Station. Here they were treated in the Quarantine Hospital until they were judged to be no longer infectious.

A special visiting medical staff was formed at the offices of the New South Wales Department of Public Health. Every case of suspected smallpox reported by a medical practitioner, or by any member of the public, was visited by a member of this staff and if the case was diagnosed to be one of smallpox, the patient was conveyed by motor ambulance to the depôt at Woolloomooloo Bay where he was embarked on the launch. All medical practitioners were notified by circular of the obligations on them to report every case of illness which might reasonably be suspected of being smallpox, and the citizens generally were warned to the same effect through the public press.

A very large number of persons were seen and examined by the visiting medical staff who proved not to have smallpox. More than 3,000 cases of chicken pox alone (which has been unusually prevalent in Sydney during the year 1913) was thus seen. As soon as the staff had obtained some experience with the particular type of smallpox of this epidemic, the diagnosis from chicken pox presented, as a rule, very few difficulties, and subsequent results showed that the number of mistakes made in diagnosis was small.

During the epidemic the method of treating contacts was twice modified. All through the epidemic, the visiting medical staff on diagnosing a case of smallpox offered vaccination to all contacts. This practice was never changed. But at the beginning of the epidemic all house contacts were also conveyed to the Quarantine Station, forcibly if necessary, and detained until vaccination was proved successful. Later on this policy was temporarily modified owing to the impossibility of housing all the contacts at the Quarantine Station during the height of the epidemic. During this period only those contacts who refused vaccination were deported to North Head. At a still later period when the daily number of cases had fallen to two or three, the practice of removing all contacts to quarantine was again put in force. The legal power for the removal and detention of both patients and contacts were derived from the Commonwealth Quarantine Act, 1908-12.

Supplies of vaccine lymph were obtained from the Commonwealth Quarantine Department, Melbourne, and issued to medical practitioners in the metropolitan district without charge.

Public vaccination depôts were opened at the Hospital Admission Depôt and at the City Town Hall. These depôts were maintained in active operation, and open daily until towards the end of the year, when they were closed consequent upon failure in the public demand for vaccination. Arrangements were also made for opening vaccination depôts at suburban town halls, and these depôts continued open as long as the public demand for vaccination continued in each district. General supervision of the vaccination depôts was undertaken by Dr. R. J. Millard, Medical Superintendent of the Coast Hospital.

On 4th July, acting under powers derived from the Federal Quarantine Act, the Federal Government declared Sydney, within an area of 15 miles from the General Post Office, to be a quarantine area. The effect of this proclamation was to prohibit persons in the area who had not been successfully vaccinated within the previous five years from journeying to another Australian State.

On 5th July a proclamation was issued by the Federal Government constituting all medical officers appointed under the law of any State of the Commonwealth relating to public health as quarantine officers of the Commonwealth. This proclamation was necessary to enable State medical officers to exercise powers under the Quarantine Act.

On the same date the New South Wales Board of Health passed a resolution recommending the State Government to immediately pass into law a Compulsory Vaccination Act. A draft Bill for enforcing compulsory vaccination was considered, adopted, and directed to be forwarded to the Premier. (This Bill was rejected in the State Parliament on 10th October, on the occasion of its third reading.) Measures were adopted for the vaccination of hospital staffs, police, postmen, and public officials, and announcements were made through the public press urging the importance of vaccination upon ships' surgeons, private firms, and the public generally.

It became evident that the demand for vaccination among the public of New South Wales would be very large and the Director of the Microbiological Laboratory (Dr. J. B. Cleland) was entrusted with the duty of establishing a lymph farm for the production of calf lymph. This was accordingly done. Dr. Cleland, with the assistance of the Assistant Microbiologist (Dr. E. W. Ferguson), installed the necessary calves and apparatus in a building in the grounds of the Coast Hospital, and began the manufacture of vaccine lymph. By about the end of July it was found that the lymph obtained from the Commonwealth Quarantine Department was not yielding satisfactory results, and on 19th August the use of this lymph was discontinued and the Department began to use its own lymph, and continued to do so throughout the year.

The continuation of a state of quarantine in Sydney was found to interfere seriously with the commercial interests of the port, and many representations were made, both to the Commonwealth and State Governments, by the mercantile community and others in favour of a relaxation of the terms of the proclamation, and on 22nd October a public meeting held in the Town Hall, Sydney, protested strongly against the continuance of the quarantine.

On 19th November a conference which took place in Melbourne between the Director of Federal Quarantine and the heads of the Health Departments of the several

Australian

Australian States, expressed the opinion that the proclamation of Sydney as a quarantine area might be safely repealed, provided that every person travelling out of New South Wales, either by land or by sea, should give a written undertaking to report the occurrence of any illness occurring within twenty-one days in himself or in persons within his charge to the health authorities of the State in which he happened to be.

On 26th November, the New South Wales Government having agreed to the terms suggested by the conference, the Federal proclamation of 4th July declaring Sydney a quarantine area was revoked.

In country districts as a rule, owing to difficulties of conveyance, the practice of removing patients to the Quarantine Station in Sydney was not observed. Many of the localities invaded were hundreds of miles from the metropolis, and the conveyance of patients to Sydney would have been quite impracticable. As a rule country cases were isolated and treated in local district hospitals, most of which in New South Wales are provided with satisfactory isolation departments for the treatment of infectious diseases. In the case of a few small country towns which were without hospitals, or in which these institutions were, owing to their construction or situation, unsuitable for the purpose, temporary hospitals, or hospital tents, were erected, and patients were isolated in them till judged free of infection. In a few instances where such a course was practicable, and seemed desirable, patients were quarantined in their own dwellings under the care of their own medical advisers. Throughout the epidemic the Police Force gave ungrudging and most valuable assistance to the Department, both in helping to maintain quarantine where the procedure was necessary, in the tracing of contacts, and generally. The members of the Police Force of the State were vaccinated or revaccinated at the beginning of the epidemic, and this measure permitted the utilisation of their services in connection with the control of the epidemic with freedom and safety.

Vaccination.

Free public vaccination depôts were opened on 3rd July, and between that date and 31st December about 500,000 persons are estimated to have been vaccinated in New South Wales, of whom 225,674 were vaccinated in the public depôts in Sydney and suburbs, and nearly 6,000 persons who were adjudged to be contacts of persons found to be suffering from smallpox. These last were vaccinated by members of the diagnosing medical staff.

There is no vaccination law in New South Wales, and previously to this outbreak the younger portion of the population were almost totally unprotected. This will appear from the statement that during the ten years ending 31st December, 1912, only 1,126 vaccinations were recorded in the whole of New South Wales; and as the Department of Public Health paid medical practitioners 2s. 6d. per head for all successful vaccinations prior to the outbreak of smallpox under review, these figures are probably fairly accurate.

The lymph used by this Department at the beginning of the outbreak was supplied by the Commonwealth Quarantine Department; but this lymph, though quite effective in the earlier weeks, very soon ceased to give satisfactory results, and its use was accompanied, in some cases, by very severe local and constitutional symptoms. Consequently, by 19th August, it was discarded, and subsequently a strain of lymph was employed which was produced by this Department from its own lymph farm.

The Influence of Vaccination.—The evidence gained from the epidemic of smallpox in New South Wales is a striking vindication of the value of vaccination. Our experience has been that whether one insertion or more were made, whether the area of the vaccination cicatrix were as large as a florin or as small as a pin's head, so long as a typical vaccine vesicle followed by a foveated pigmented cicatrix was produced, the protection afforded against smallpox was absolute for the time being. The whole epidemic lasted for a period of time too short to afford any evidence as to the duration of the protection.

In reviewing the available evidence as to the efficiency of vaccination in protecting against attack, it will be apprehended that that class of evidence has the greatest value which deals with the staff which had the control of the epidemic, because not only were the members of that staff more exposed to the risks of infection than the public generally, but they were constantly so exposed. Moreover, their vaccinal state could be easily and certainly ascertained.

The staff employed by the Commonwealth of Australia at the Quarantine Hospital, where nearly all the metropolitan patients were treated, numbered fifty-two, of which four were medical officers and forty-eight were nurses or hospital attendants. All the above were successfully vaccinated or revaccinated at the outbreak of the epidemic, and none of them contracted smallpox. The staff employed by the New South Wales Health Department, and coming into dangerous relationship with infectious cases, numbered fifty. Seventeen of these were medical officers employed in visiting and diagnosing suspected cases; five were sanitary inspectors; four were members of the disinfecting staff employed in disinfecting houses from which smallpox patients had been removed; twenty-four were nurses who were employed in nursing country cases, and a few metropolitan patients who for various reasons could not be removed to the Quarantine Hospital. The whole of this staff were successfully vaccinated or revaccinated at the beginning of the epidemic, excepting one member of the disinfecting staff. This man managed to evade the general instruction which had been issued to the staff to undergo vaccination. He had never been vaccinated in his life, and *he alone of the whole of the two staffs contracted smallpox.*

Among those persons who suffered from smallpox the vaccination statistics were as follows:—Sixty-seven persons stated that they had been vaccinated in infancy, but in

only

only forty-six of these were any vaccination scars visible. All of these sixty-seven persons were adults, and the majority were over 40 years of age. Among them were two persons who claimed to have been revaccinated—one of them thirteen years and one twenty years—before being attacked by smallpox. In addition to those persons said to have been vaccinated in infancy, two of those attacked in the Sydney epidemic claimed to have been vaccinated previously—one thirteen years and one fifteen years—before they were attacked. One of the two in this last group showed a vaccination cicatrix but in the other case there was no such mark to be found.

Passing to the subject of recent vaccination, it was found that, with two doubtful exceptions, no person who had been successfully vaccinated during the course of the epidemic afterwards contracted smallpox. By this one does not mean to say that no person who had undergone the operation of vaccination afterwards contracted smallpox. On the contrary this happened in sixty-one instances. But with the two doubtful exceptions above referred to, in all the sixty-one instances the vaccinations had either been followed by no reaction whatever (thirty-nine cases), or had resulted in the aberrant reaction which Seheult has christened a "mulberry" (twenty cases), a reaction which, when it follows vaccination in a person who has not already had smallpox, appears to be due to defective lymph. A vaccination followed by this reaction does not afford protection either against subsequent vaccination or against smallpox. The two doubtful cases were those in which vaccination had been performed thirty-eight days and two months respectively before attack by medical practitioners, who, afterwards, gave certificates of successful vaccination, but when seen by us, the vaccination scars were not foveated or depressed, and would not have been accepted by a member of the staff of the Department as indicating successful vaccination. The other 943 persons who were attacked during the epidemic had never been vaccinated.

These statements may be condensed as follows:—Of the 1,673 persons attacked to 31st December, 1913, in the New South Wales epidemic of smallpox, sixty-nine, or 6·4 per cent. had probably been vaccinated in infancy or over thirteen years before being attacked; 1,004, or 93·3 per cent. had never been successfully vaccinated before contracting the infection of smallpox.

The failures in vaccination indicated were due to the inferiority of the lymph used by the Department during one period of the epidemic.

Even these figures, powerful argument as they are in favour of vaccination, do not, by any means, disclose the whole of the case in its favour. Many instances occurred in the earlier part of the epidemic in which infantile vaccination was quite effective in protecting adults from infection. Cases, for instance, were not infrequent in which all the children of a family (born in New South Wales and therefore unvaccinated) were attacked by smallpox, while the parents who had been born in Europe and vaccinated in infancy, escaped infection. Sydney was, probably, prior to this epidemic, as regards the younger portion of its inhabitants, the worst vaccinated of any civilised community in the world. At the present time over 50 per cent. of its population is successfully vaccinated, and, therefore, effectively protected against smallpox for some years to come.

Another kind of evidence is that afforded by the results of vaccination of contacts. Nearly 6,000 persons, who were discovered to have come into close contact with persons diagnosed to have smallpox, were vaccinated during the epidemic by the medical staff of the Department (quite apart from vaccinations performed in public vaccination depôts, or by private practitioners), and in all cases in which vaccination was performed within two days of exposure to infection and was successful in producing a normal vaccinal reaction, the vaccinated person was protected against smallpox. The only failures were the instances in which the exposure had been three or more days before vaccination took place, and the latter had, therefore, been unable to "catch up" with the infection. Our experience in this direction was in accord with the observation of Marson (Reynold's System of Medicine), that vaccination within two days after exposure to the infection of smallpox will usually avert the attack of the latter disease.

In quite a number of instances during the epidemic, the person attacked by smallpox was the only unvaccinated member of his household. Such an event generally occurred in households residing near a dwelling in which a case or cases of smallpox had occurred between two and three weeks previously, and the other members of the household had been vaccinated in consequence as a precautionary measure.

To quote Wanklyn, our experience of the efficacy of vaccination during the Sydney epidemic was that "anyone who is recently and successfully vaccinated cannot by any loss of health, by any degree of exposure, or by any possibility of any kind at all, contract smallpox."

"The "mulberry" reaction which has been referred to in this report as occasionally following vaccination has been already described by Seheult, in his account of the Trinidad epidemic of mild smallpox. This reaction may be produced under various circumstances. It was commonly and most frequently seen in Sydney after the vaccination of persons who had already suffered from the Sydney epidemic of smallpox. Vaccination of persons who were suffering, or had suffered, from smallpox in the vast majority of instances was followed by no reaction; but in a minority of cases a slight and very much modified reaction resulted, which consisted in the delayed appearance at the site of inoculation of a red mulberry excrescence which either dried up without any further development, or which eventually resulted in ill-developed vesicles often containing some blood. There was an absence in these cases of the inflammatory zone round the vesicles and usually a lack of constitutional symptoms. When the vesicle dried up it formed a thin scale which on falling off left a small red excrescence which gradually became absorbed. No cicatrix finally resulted, but the skin remained stained for some weeks.

A similar reaction to the above was sometimes observed to follow the revaccination of persons who had been previously vaccinated (in infancy), but had not suffered from smallpox. It was also occasionally observed in persons who had never either been vaccinated or suffered from smallpox. In these cases it appeared to be due to some defective quality in the lymph, and as has already been stated, a primary vaccination followed by such a reaction gave no protection against subsequent attack by smallpox. In Sydney most of the instances in which the "mulberry" reaction followed the vaccination of persons who had not had smallpox were consequent upon vaccination done with a particular strain of lymph which was soon discarded on account of its proving inefficient.

It is to be noted here that the vaccination of persons actually suffering from the eruption of smallpox in the Sydney epidemic was occasionally, though very rarely, followed by a good reaction. Most of such successful vaccinations were done within one or two days after the smallpox rash appeared, and the latest case noted was one in which successful vaccination was performed on the third day after the appearance of the smallpox rash. This observation is in accord with the observations of Ricketts and of Hibbert and Robinson, all of which relate to the classical and more severe type of smallpox.

The following Table shows the number of Vaccinations performed annually by Government Vaccinators during the twenty years preceding the epidemic of 1913:—

Year.	Vaccinations.	Year.	Vaccinations.	Year.	Vaccinations.
1893	2,547	1900	911	1907	39
1894	1,057	1901	2,081	1908	42
1895	2,437	1902	895	1909	11
1896	945	1903	605	1910	280
1897	245	1904	20	1911	20
1898	592	1905	32	1912	35
1899	1,197	1906	42		

Infectivity of the Sydney Epidemic of Smallpox.

Infectivity in this epidemic appears frequently to have had a low intensity. For instance, in two cases early in the epidemic, before the diagnosis of smallpox was made, persons who suffered from very mild attacks (in one case there were only three or four lesions on the whole surface of the body) failed to carry infection into their families though they occupied the same bedrooms as other unvaccinated members of the family. In cases accompanied by a copious rash, the infectivity of the disease appears to have been fairly intense, and in households unprotected by vaccination as soon as a diagnosis of smallpox in one member of the family was made, the disease has generally attacked all the members of the household This state of affairs was chiefly observed at the beginning of the epidemic, or in families where the earliest case was concealed or overlooked, as later on, when one member of a household was found to be attacked, all the other inmates were promptly protected by vaccination. The slow spread of the epidemic in an almost entirely unvaccinated population was no doubt due to the degraded infectivity. In most cases infection appears to have been conveyed by direct personal contact, and in quite a number of instances young men and women were found to have infected members of the opposite sex with whom they had been "keeping company;" on the other hand, the convection of infection by fomites was not much in evidence. Two striking examples to the contrary were that of a young woman who borrowed a handkerchief from an acquaintance suffering from a mild attack of smallpox, and was herself attacked twelve or thirteen days later; and the case of an old man who slept one night in a bed which had the previous night been occupied by a smallpox patient with whom he had not been otherwise in contact. He also sickened with smallpox about a fortnight later. But, in both these cases, there were special opportunities for infection. As a rule, the progress of the epidemic could be traced by direct and close personal infection from person to person.

The evidence from the behaviour of the epidemic outside Sydney also points to low infectivity. In the course of the epidemic twenty-eight country towns or districts of New South Wales were invaded by smallpox, and the total number of cases diagnosed in these localities only amounted to fifty-eight. The greatest number of persons attacked in any one locality was eight, and in sixteen localities only one person was attacked. In all but six of the localities invaded, the first person, or the only person attacked, had come from Sydney, where he had been infected. In five instances the evidence of the source of infection was doubtful, and in one instance the person attacked had been infected in New Zealand. In country places, therefore, when the authorities were on their guard, and ordinary measures of segregation and vaccination were enforced from the earliest diagnosis of an imported case of smallpox, the disease did not spread.

Conclusions.

1. The epidemic prevalent in Sydney during the latter half of the year 1913 was a mild type of smallpox, and was identical with the epidemic infectious disease variously known as "Cuban itch," "Alastrim," "Spanish measles," Milk-pox," "Lumbermen's itch," &c, which has prevailed during recent years in various parts of the Americas. The disease was probably introduced into Sydney from Canada.

2. Recent successful vaccination conferred absolute protection against infection during the Sydney epidemic.

3. Besides being mild in its manifestations, the disease had a relatively low infective power, and was, as a rule, transmitted only by personal contact. Transmission by fomites, or by aerial convection, rarely occurred.

4. As regards diagnosis the only confusion liable to arise is between this disease and chicken-pox. Such uncertainty is only likely to occur in respect of a few of the milder cases of this mild type of smallpox, and it may be overcome by paying attention to the distribution of the focal rash and to the manner of onset, both of which are distinctive from that of chicken-pox. In a minor degree the characteristics of the individual lesion are also of value in diagnosis. For instance, the clear watery pock which collapses easily on pressure with the finger-nail with escape of its watery contents is very frequently present in some stage of an attack of chicken-pox, and is never seen in mild smallpox. Some other characteristics of the focal lesion, such as shape, irregularity of outline, umbilication, and the occurrence of the rash in successive crops, have no great value in the diagnosis of chicken-pox from mild smallpox. At the beginning of an epidemic of mild smallpox, diagnosis should be controlled by vaccination results.

5. The question of prevention centres round that of vaccination. In a well-vaccinated and revaccinated community the disease cannot spread. In an unvaccinated community it will certainly spread unless the earliest cases are sufficiently severe to attract attention, because many of the cases are so mild that patients will not regard their attacks seriously, and refuse to seek medical assistance. Smallpox in Sydney was almost entirely confined to the poorer neighbourhoods, because the better educated classes nearly invariably sought vaccination or revaccination as soon as the existence of smallpox in an epidemic form was publicly notified.

II.—MICROBIOLOGICAL FINDINGS AND ANIMAL INOCULATIONS.

(J. Burton Cleland and E. W. Ferguson.)

There has been some discussion and doubt in certain quarters as to the exact nature of the recent variola-like epidemic, which has occurred in New Zealand and New South Wales. Whilst the various health authorities in Australia and New Zealand are all agreed that the disease was smallpox or variola, some medical men have considered that the complaint was a distinct entity separable from smallpox and chicken pox. They, and probably quite rightly, considered it to be "alastrim," but the evidence available in connection with this disease alastrim in America seems to indicate that it is unquestionably a form of smallpox. That our disease is also a form of true smallpox we have the following evidence to submit in proof:—

General Considerations.—The epidemiological identity of different manifestations of any particular disease is acknowledged when the same specific micro-organism is found to be responsible for the differing effects. Thus in different epidemics of any infectious disease there may be increased or diminished virulence and special manifestations particular to one or the other. An epidemic of plague may be entirely pneumonic or entirely bubonic, yet no one considers that in consequence we are dealing with two separate diseases. Scarlet fever, as at present known in Australia, is a comparatively mild complaint, thus differing from the severe epidemics known years ago elsewhere. Whilst in individual cases of disease in the epidemic the effects on the patient will vary according to the soil in which the organisms are planted, the seed being of the same strain in each case, in the various epidemics we have a superadded feature, and that is variation, little or great, in the nature of the organism. All living creatures vary more or less in each new generation. Where countless generations occur in the course of a few days the variations might be expected to be great. Strange to say, however, as regards the organisms of infectious diseases in man the various generations seem to breed true to a remarkable extent in spite of such ample opportunities for differing. Naturally, in many cases, the only indications we have that they do breed comparatively true is in the organisms producing a very similar condition of disease in their hosts in different epidemics. It is a matter well known, however, that whilst some epidemics of infectious diseases are inordinately severe, others are remarkably mild, in spite of the soil being presumably almost identical. If, therefore, one epidemic is decidedly milder with a negligible mortality than another, we have no grounds for supposing that merely because it shows these features it is not due to the same disease and the same specific organisms as are responsible for the other epidemic, with very severe symptoms and a heavy mortality. The mere mildness of the recent epidemic in New Zealand and New South Wales cannot, therefore, alone be considered as indicating that it was not due to the same specific organism as that producing the more fatal smallpox of the far East. It may be well here to point out that in a general way it is of no advantage to a disease germ to kill or incapacitate its host, as thereby its survival in nature may be rendered the more precarious. It is to the interests of the invading organisms and of their host that as far as possible they should all live together in peace and concord and that the invading organism should harm its host as little as possible, and the host injure the invaders not at all.

There are now recognised a few diseases which are due to ultra-visible viruses of unknown nature. We would be perfectly unaware of the existence of such viruses were it not that during their life histories in the different hosts they injuriously affect these to a greater or less extent. It is possible that a number of slight complaints, which merely incommode for a few hours or days their respective hosts, as, for instance, many highly infectious febrile complaints, may be due also to ultra-visible viruses, and that, further, we may be surrounded, and in fact living in symbiosis with vast armies of such organisms, which in the course of ages have so accommodated themselves to their hosts that they produce now no recognisable ill effects. The organism responsible for variola is probably closely allied to this group. From these observations it will be gathered that

that there is probably a tendency for all virulent diseases in the course of ages to become less virulent, mutation in this direction being of advantage to the organism by enabling it to multiply more freely. Therefore, from time to time in such diseases as smallpox, measles, and scarlet fever, we should expect to find milder forms arising by such mutations and maintaining themselves in the community more easily than the virulent forms. The present epidemic of smallpox we take to be an instance in point.

Vaccinia, the Present Epidemic and Smallpox.—Consideration has at times been given to the question as to whether cowpox is due to the same specific organism as that producing smallpox in man, whether it is a variant of this, or whether it is sufficiently distinct to be ranked as a different species and yet sufficiently close to be able to produce in its hosts antibodies capable of protecting against smallpox, this being due to the two organisms having a common ancestry. That cowpox is actually due to the same specific organism as smallpox seems to be conclusively proved, however, by the fact that material from smallpox patients can be conveyed to calves, and that after a few generations in these animals it produces a disease in them transferable back to man whose course is now identical with that of the natural disease cowpox. In other words, at will the disease smallpox can be converted into cowpox, though the converse cannot be brought about. We are in the dark at present as to how the high contagiousness of smallpox is thus lost on transmission to the cow. It has been suggested that in the complicated life-history of the organism only a certain phase is capable of taking place in the cow, and that once this loss has been achieved for a few generations the hereditary tendency for it to reappear on conveyance back again to the human host is lost. This, however, is beside the question before us.

The cases seen in the present epidemic seem to us to exhibit a "half-way house" stage between ordinary severe smallpox and vaccinia. Though the disease is contagious it is not so markedly so as ordinary smallpox. Though the patient may be covered from head to foot with pustules, the secondary fever is remarkably mild when compared with semi-confluent or ordinary smallpox. The large number of cases in which only a few pocks developed indicate that the white race has a comparative immunity to this disease as compared with ordinary smallpox, but that this immunity is less than that to generalised vaccinia. The impression has also been left upon us that the skin lesions are less deep than in ordinary smallpox. By analogies, therefore, with vaccinia the conclusions we seem justified in coming to are these: That the present epidemic is due to the same specific organism as smallpox, that it is probably due to a mutational change in this organism by which its virulence is diminished and possibly some phase of its life-history eliminated, and that it is probable that it is unlikely to recover the general intense virulence of ordinary smallpox.

Cytorhyctes Variolae.—During the course of the epidemic opportunity has been taken to search for the supposed parasite of smallpox, *Cytorhyctes variolae*. Various investigators have detected in the epithelial cells, and also in the nuclei of these cells, various bodies which they have considered as foreign to the host cells, and as representing either actual parasites or a reaction in the cells to the presence of such bodies, the parasite itself being hidden as under a cloak in the centre of the reactionary area (*Chlamydozoa*). Unfortunately all the cases in which it was possible to obtain material showed already considerable leucocytic infiltration of the pocks. As the supposed parasites are most easily recognised in the stage preceding this, investigations in this line were naturally hampered. Nevertheless, in one case, by Ross's new jelly method of investigation of living cells, bodies were seen in the protoplasm of what appeared to be epithelial cells identical with the description of *Cytorhyctes variolae*. Unfortunately there is no distinctive reaction of these bodies, as for instance in the shape of chromatin, to specifically identify them as organisms, and not cell products. One cannot, therefore, be certain that the bodies seen were not degeneration products of the cells. In preparations made by the wet method of fixation, either by osmic acid vapour or by corrosive sublimate-acetic acid, and stained with iron hæmotoxylin or Giemsa's stain, nearly all the cells met with consisted of leucocytes. In these cells foreign bodies were also seen from time to time, which may have been engulphed *Cytorhyctes*, or may have merely been further degeneration products.

Tissues from Smallpox Patients.—The tissues that we have had an opportunity of examining have consisted of pocks from the skin, and the placenta and some of the organs of a patient who died suddenly during the course of delivery, on the fourth day after the eruption had first appeared. The following is a description of the appearances met with.

Pocks in the Skin.—Sections (Plate 1) through pustules showed areas of various sizes in the skin, as a rule larger near the surface and extending to the rete malpighii, due to the separation of the epithelial cells by a transudation of lymph accompanied with an exudation of leucocytes. In some instances the pustule was broad and almost as wide near the rete malpighii as at the surface, whilst in other cases it showed a more wedge-shaped arrangement with a wide base narrowing towards the apex, exhibiting a kind of radiating appearance. In the deeper pustules vesiculation had separated the malpighian cells from the cutis vera, but did not seem to have extended deeper, although there was some polymorphonuclear infiltration of the cutis vera immediately below the vesicle. The polymorphonuclear leucocytes showed in great part nuclear degeneration and fragmentation. In many the nuclear fragments assumed the appearance of rounded scattered bodies dark on one side with a lighter ring on the other, and of varying size. Further sections were stained by Giemsa's method, and were also put through Levaditi's process, but no definite parasitic bodies were detected. A special search was made for spirochætes.

The

The kidney, liver, spleen, and placenta were also examined by these latter methods, but with negative results. In the kidney the cells of some of the convoluted tubules were granular with indistinct outlines and somewhat swollen. Apart from this nothing abnormal was detected, as was the case also in the liver and spleen. The placenta showed some interesting changes. There was nothing very remarkable to the naked eye about it in its preserved state as received by us. Some dark patches under the surface appeared to be dilated veins or blood spaces. Sections (Plates 2, 3, 4) showed a polymorphonuclear infiltration in parts, and also areas in which the chorionic villi had definitely undergone cell necrosis. There were also areas of blood extravasation, and also numerous places in and around the villi which showed nuclear fragments without definite cell outlines. The appearances presented suggested that, through the cutting off of nutrition to the villi, some of these had undergone degeneration and consequent invasion by polymorphonuclear leucocytes. This diseased condition of the placenta seems to afford a reasonable explanation for the frequency of abortions in the present epidemic. As the epithelium of the chorionic villi has the same epiblastic origin as the surface epithelium of the body, special search was made to see whether any changes could be detected suggestive of a condition equivalent to the pustules found in the skin. Perhaps the polymorphonuclear invasion may be associated with such a change. The histological description of the skin lesions found in this case are strictly comparable to those described for true smallpox.

Animal Experiments.—With some doubtful exceptions, attempts to convey chicken pox to animals have signally failed. On the other hand, inoculation of materials from smallpox patients have proved successful and strains of vaccinia have been derived from such a source. It was, therefore, obvious that light might be thrown upon the nature of the present epidemic by an attempt to convey material from the pustules to calves. Such conveyance, if successful, would undoubtedly exclude the possibility of the disease being a form of virulent chicken pox.

During the course of the epidemic material was obtained from four patients about the fourth or fifth day after the first appearance of the rash—the material from each patient being kept separate. The lesions were in the condition of pustulation. The material thus obtained was conveyed to an isolated shed far removed from human habitations or the vaccine establishment. The first procedure was the inoculation of a bull calf on 10th October. The material obtained, after dilution with approximately an equal amount of 50 per cent. pure glycerine and water, was applied to small scarified areas on the abdomen of the calf. At the end of four days the areas were covered by fine yellow flakey crusts. There was no definite œdema or swelling, but some slight redness was present round one area. As a control to these four areas a further area had been scarified, and glycerine and water alone rubbed in. All four inoculated areas did not show the same degree of reaction, one being decidedly less. It was doubtful from this experiment whether any definite "take" had been obtained, though this seemed probable.

Two days later a second calf, a heifer, was similarly inoculated with material scraped from the previous case, and emulsified in glycerine and water. Four days later the inoculated areas showed dried scaly crusts more decided than in the first calf. These were slightly adherent, but there was no redness or œdema about them, and no definite swelling. They were scraped and the material preserved for further inoculations. Five days after scraping a re-examination of the areas showed in their neighbourhood several small papules, one of which had become a pustule. It seemed from this experiment that a "take" had been secured, though the result was still slightly indefinite.

On 7th November a further calf was inoculated on four areas with the four different strains. At the end of four days there was a very definite reaction. The lines of scarification were showing up well. There was a moderate amount of scabbing with, in some of the cases, decided redness and swelling and the presence of vesico-pustules. There was now no doubt at all that a successful "take" had been established.

A fourth calf was variolated with material of the third remove on 11th December, and took as in typical vaccinia; and on 15th January the fifth remove was obtained from Calf 6, when a large area was inoculated for the purpose of obtaining seed. The "take" in this instance was indistinguishable from that of typical vaccinia. It would, therefore seem that in the fourth remove and onwards the reactions obtained were indistinguishable from those of vaccinia. In addition to this attempt to produce typical vaccinia in calves from material obtained from the smallpox patients, these same animals were made use of to test further the relative protection obtained from the varioloid vaccine against vaccinia and *vice versa*. Much interesting information has been obtained in this way, and it may be well first of all to summarise the results obtained from the various calves experimented with, and then to discuss the bearing of these results.

Summary of Inoculations made on Calves.

Calf 1.

Oct. 10.—Variolated directly from four human cases on four small scattered areas, each about ¼ sq. in. in superficies. *Result:* A slight, somewhat doubtful "take."

Oct. 21. Vaccinated over an area about 3 in. by 1 in. *Result:* Good typical "take."

Nov. 7.—Revariolated with material from first and second removes over two small areas, each about a square inch in area. *Result:* Definite slight "take."

Nov. 24.—Revariolated with the second and third mixed removes over two small areas, each about 1 sq. in. in surface. *Result:* No definite "take."

Dec. 11.—Revariolated with the third remove over two similar small areas. *Result:* Definite light "take."

Dec. 30.—Revaccinated over an area about 3 in. by 1½ in. *Result:* Definite slight "take."

Calf

CALF 2.

Oct. 16.—Variolated with the first remove over four small areas, each about 1 sq. in. in extent. *Result:* A definite slight "take," more decided than in the case of Calf 1 on 10th October.

Nov. 7.—Revariolated with the first and second removes over two small areas of about 1 sq. in. each in extent. *Result:* Moderately good "take."

Nov. 24.—Revariolated with the second and third mixed removes over two similar small areas. *Result:* No definite "take."

Dec. 11.—Revariolated with the third remove over one area of about 1 sq. in. in size. *Result:* Definite moderate "take."

Dec. 30.—Vaccinated over an area of about 3 in. by 1½ in. *Result:* Definite moderate "take."

CALF 3.

Nov 7.—Variolated with the second remove over four small areas, each about the size of 2 sq. in. *Result:* A "take" almost as good as in typical vaccinia.

Nov. 24.—Revariolated with the second and third mixed removes over two small areas as in Calves 1 and 2. *Result:* A slight but definite "take."

Dec. 11.—Revariolated with the third remove as in Calves 1 and 2. *Result:* Definite moderate "take."

Dec. 30.—Vaccinated as in Calves 1 and 2. *Result:* A slight "take."

CALF 4.

Dec. 11.—Variolated with the second remove mixed lymph, the third remove mixed lymph, and the four separate lymphs of the third remove, over six areas, each about 2 sq. in. in extent. The total area variolated was about 12 sq. in. *Result:* A "take" as in typical vaccinia.

Dec. 30.—Vaccinated. *Result:* No definite "take"—crusts of the previous variolations still present.

CALF 5.

Nov. 24.—Vaccinated for the purpose of preparing vaccine lymph over an extensive area, probably amounting to 60 sq. in. A typical result.

Dec. 17.—Revaccinated on the side. *Result:* No "take," but it should be noted that this was an unfavourable site for revaccination.

Jan. 9.—Variolated over an area of about 3 sq. in with the fourth remove. *Result:* Fairly definite, but very slight, "take."

Jan. 22.—Revaccinated. No "take."

CALF 6.

Jan. 15.—Variolated with the fourth remove mixed over a large area of the abdomen, amounting to about 50 sq. in. *Result:* A good "take," as in typical vaccinia.

Jan. 22.—Vaccinated. Suggestive of a slight "take."

CALF 7.

Feb. 27.—Variolated extensively from Calf 6. Typical "take."

MONKEY.

Nov. 15.—Variolated on the arm as is done in vaccinating children, with lymph of the third remove, consisting of strains from two patients and the mixed strain from the four. This monkey took as in an ordinary vaccinia. There were some secondary papules about the primary lesions; no generalisation occurred.

Jan. 22.—This monkey and another fresh monkey were each vaccinated on the arm with ordinary vaccine lymph in three places. On the ninth day the new monkey showed on each of the areas adherent yellowish-brown heaped-up scabs on a slightly indurated base, with a slight surrounding red flush. *Two of the areas on the original monkey's arm showed normal skin*, with the remains of the scratches, *but the third spot showed a heaped-up yellowish-brown, mulberry looking scab*, the size of a threepenny piece. This occurrence after previous variolation of a mulberry reaction in one area and of no reaction in the other two, is of very great interest.

From a study of these animal experiments, the following points may perhaps be deduced:—

1. On direct conveyance of a small amount of materia from a recent human pustule to a calf, the "take" is at first very slight; is more definite, but still slight, in the second remove; is marked in the third remove, and assumes the appearance of typical vaccinia in the fourth remove. How far these progressive changes are due to the small amount of material available for the first and second inoculations, and how far to an increased accommodation of the organism to the new host, is impossible to say. Calves 3 and 4 seem to indicate that there was such a progressive accommodation.

2. A very slight imperfectly variolated area will not apparently modify a subsequent vaccination.

3. Such a subsequent vaccination, if only over a small area, will modify, but will not entirely prevent, successful results on revariolation and revaccination (Calf 1).

4. An extensive area of recent variolation may completely protect against subsequent vaccination (Calf 4).

5.

5. An extensive area of vaccination will profoundly modify attempts at variolation six weeks later, but may not absolutely prevent all reaction.

6. Variolated lymph of the third remove can produce an appearance in monkeys resembling typical vaccinia, unaccompanied by any generalised eruption.

7. It is very obvious that the size of the area variolated or vaccinated is a very important factor as regards complete protection against subsequent variolation or vaccination, or *vice versa*. The time factor and the degree of reaction also probably play a part.

8. The results obtained from calves, whether variolated or vaccinated, seem to be identical.

Conclusions.—From the above given microbiological data, we have attempted to show that the present disease is a form of true variola. We have come to this opinion on the following grounds :—

1. Such a modified variola was what, on microbiological grounds, might have been expected to arise.

2. The disease, in some of its features, seems to be intermediate between ordinary variola and vaccinia, though so close to the former as to be in most respects indistinguishable.

3. Bodies resembling the *Cytorhyctes variolae* have been seen in material from cases.

4. The appearance of sections of tissues from cases accord with those described from smallpox patients.

5. The disease is conveyable to calves by inoculation.

6. The condition thus produced behaves as does inoculated vaccinia.

7. This inoculated disease and vaccinia are mutually more or less completely protective against each other, provided that a sufficient area be inoculated.

Appendix.

Details of Experiments in the Conveyance of Varioloid Material to Calves.

On 9th October, 1913, material was obtained from the pustules of three patients suffering from the mild form of variola then epidemic in Sydney. The material was obtained from unbroken pustules on the limbs. The pustule was broken by a sharp scalpel, and a small amount of the thick, curdy pus present in it was scraped up on the end of the scalpel and mixed in a small amount of 50 per cent. pure glycerine in water. The resulting dilution of the varioloid material probably in no instance was equal in weight to the glycerine and water solution to which it was added, though it approximated to this amount. In addition, a little pure lymph was taken up in capillary tubes and searched for parasitic bodies by means of dark field illumination and special staining methods.

The details of the cases from which the material was obtained are as follows :—

A. "*C.M.*," *Female.*—The rash at first appeared on 4th October ; it was now profuse on the arms, legs, and face, which showed marked pustules.

B. "*E.J.W.*,"*Male.*—The rash first appeared on 5th October, and on 9th October there was a profuse pustular rash on the arms, legs, and face.

C. "*A.J.C.*," *Male.*—The rash first appeared on 4th October, and was now similar to the two previous cases.

D. In addition to the three foregoing cases from whom material was obtained on 9th October, pure lymph had been obtained in capillary tubes from a patient, "*W*" a week previously, and had since been stored on ice. This lymph had not been treated with glycerine.

The material thus collected was kept in a cool place until next day, when on 10th October the following experimental inoculations were made :—

Calf 1.—Bull calf aged eight to nine months.

October 10.—The animal was inoculated with material from the four cases indicated above as follows :—The inoculation was made by scarifying small areas by means of an ordinary toothed vaccine scarifier as used for human beings. The abdomen and groins of the calf were carefully shaved.

A. The right groin and the abdominal wall in front of this were scarified over two small areas, the external one being seeded with glycerinated material, and the inside area with a little pure lymph collected in a Widal pipette.

B. Two smaller areas in the middle line in front of the scrotum were similarly seeded, the right with glycerinated material and the left with the pure material.

C. The left groin was similarly treated to the right one, and seeded with glycerinated lymph on the outside and pure lymph on the inside.

(There is some doubt as to whether the glycerinated lymph from cases "B" and "C" were not accidentally transposed.)

D. In this case a small area was scarified behind the scrotum and the pure lymph worked in after scarification.

After vaccination the parts were protected by a loose gauze sling and covered on the outside by a calico wrapping.

October 13.—The inoculation seemed to be taking as seen from underneath the coverings, dry, scaly scabs being noticed.

October

October 14.—Fine, yellow, flaky crusts were present over each inoculated area. These were easily removed by a Volkmann spoon. The scraping left very little redness beneath the scabs. This was most evident in case "C," where apparently there was a slight definite reaction. From this case "C" there was very little crust, if any, from the area seeded with pure lymph. Crusts in the groin from case "A" were the slightest of all, and for the most part were easily rubbed off. At the time these crusts were obtained it was doubtful from the appearances presented whether any definite take had actually occurred.

The crusts thus obtained, on return to the laboratory, were mixed with an equal weight of 50 per cent. pure glycerine in water. After softening in this solution, they were then ground up and used for further experimental purposes, being stored meanwhile in an ice chest.

Calf 2—Heifer.

October 16: Small areas on the lower abdominal wall and in the groin of this calf were raked, by means of a vaccination rake, so that the linear incisions barely drew blood. The inoculations were made as follows with material obtained from Calf 1, and the various areas kept separate:—

Case "A," first remove: The area to the right of the middle line inoculated.

Case "B," first remove: The right groin and adjacent part of the abdominal wall inoculated.

Case "C," first remove: The area to the left of the middle line inoculated.

Case "D," first remove: The left groin and adjacent abdominal wall inoculated.

By means of a fine vaccination scarifier, the material was seeded in, finer scarifications being made in addition to the lines left by the rake. After vaccination the areas were then protected with gauze and calico covers.

October 20: The inoculated areas showed more decided dry, scaly crusts than in the first calf. These crusts were slightly adherent: there was no redness or œdema around them, and no very definite swelling. They were easily removed with a Volkmann spoon, and on return to the Laboratory were mixed with 50 per cent. glycerine in water. At the time of taking these crusts it seemed as though the take had been successful, although so far one could not be certain of this.

October 25: The inoculated areas were re-examined, and on the delicate tissues of the right groin over the inoculated area two or three small papules were noticed, one of which on squeezing exuded a small amount of purulent material. These papules and the pustule seemed to indicate that in this case reinfection by the varioloid vaccine had taken place from the scraping on 20th October.

Two calves having now been vaccinated, giving as results variolated lymph first remove to variolated lymph second remove, it was thought that the first calf might with advantage be tested as to its reaction to ordinary vaccinia. Consequently on 21st October an area about 3 inches long and $\frac{3}{4}$ of an inch wide was raked and scarified, and seeded with the ordinary stock calf vaccinia seed. This inoculation took in the ordinary typical manner, giving heaped-up yellow crusts over the vaccinated area. There was no marked œdema around these crusts, but, since the results of vaccinia vary so much in different calves, this absence of any marked œdema cannot be certainly attributed to any protection obtained from a previous inoculation from the varioloid cases.

After Calf 1 had completely recovered from its vaccinia and the scabs had all fallen off, leaving a perfectly clean area, this calf, Calf 2 and a fresh calf were all inoculated at the same time and under the same circumstances on 7th November. The results of the individual animals are as follow:—

Calf 1.

(Previously inoculated with material direct from a varioloid patient on 10th October with a doubtful take, and successfully vaccinated with vaccinia on 21st October.)

Area No. 1: A small area on the right side of the lower part of the abdominal wall was raked, scarified and seeded with the mixed lymphs obtained from the first remove. A similar area was inoculated on the left side with the mixed lymphs obtained from the second remove. As a control an area in the middle line in front of these two was raked and scarified with 50 per cent. emulsion of glycerine. These areas took as follows:—

November 10: Area glycerinated alone: nothing definite, occasional dry flakes. Area inoculated with material from first remove: covered with decidedly more definite dry flakes, shows slight induration. Area inoculated with material from the second remove, the scabs are more heaped up than in No. 1. On raising them a moist surface is noticed below; there is no areola, but slight induration.

November 11: Glycerinated area: nothing except very slight, dry scales. Area No. 1, slight dry scabs are present; there is no induration or redness along the lines of scarification. Area No. 2, marked heaped-up yellow crusts over the area with definite infiltration and slight surrounding redness. On scraping this area a raw surface was left, the lines of scarification showing up.

On this date areas Nos. 1 and 2 were scraped, and the materials which were kept separate were mixed with glycerine in water.

November 13: Glycerinated area, nil. Area No. 1, slight scabs over the scraped area; area No. 2, covered with scabs.

November 14: The old scar of vaccination was smooth and clean. Glycerinated area showed nothing; area No. 1 showed a slight blood-tinted crust; area No. 2 showed marked, dry crusts with no œdema,

CALF 2.

(Previously variolated alone with material from the first remove).

November 7 : Three areas on the abdominal wall were treated just as in Calf 1.

November 10 : Glycerinated area, only occasional dry crusts ; area No. 1, showed dry flakes more heaped up in places ; area No. 2, showed a thickish, yellowish scab with a moist surface below it, and a definite slight areola around it.

November 11 : Glycerinated area, nil, the lines of scarification just preceptible, a few slight dry scales ; area No. 1, dry scales present decidedly more marked along the lines of scarification ; area No. 2, marked slightly moist, raised, yellow scabs, decided œdema and a moderate amount of swelling extending for about a quarter of an inch round the area inoculated, the lines of scarification definitely discernible—on scraping, a raw surface left.

November 13 : Area No. 1, almost quite clear ; area No. 2, covered with scabs.

November 14 : Glycerinated area, nil ; area No. 1, slight crusts and doubtful slight swellings ; area No. 2, marked adherent crusts with definite swelling but no redness—a slightly moist surface was left under the scabs.

CALF 3.

This calf was a fresh one

November 7 : Besides being inoculated on this day as Calves 1 and 2, it was also inoculated with material from the second remove of cases A, B, C, and D, The small areas treated with these materials were situated round the shaved umbilical area as follows :—

A. Posteriorly and to the right.
B. Anteriorly and to the right.
C. Anteriorly and to the left.
D. Posteriorly and to the left.

November 10 : Glycerinated area, nil, slight flakes ; area No. 1, a considerable number of dry flakes, slight redness, swelling doubtful ; area No. 2, the inoculation appearing definitely along the lines of scarification as papular pustules with slight scabs, a definite areola present, and swelling. Areas A, B, C, and D, showed crusts forming along the lines of scarification, and C and D had slight redness. The least reaction was present in A, where there was only doubtful swelling.

November 11 : Glycerinated area, the lines of scarification were visible, there were some fine dry scales. Area No. 1, no swelling and no redness, a moderate amount of dry, heaped-up crusts which could be easily removed, leaving a dry surface ; on scraping, the surface was somewhat raw however. Area No. 2, moderate redness and œdema, the lines of scarification showing up well with pustules in them. There was a moderate amount of scab, but less than in the other two calves vaccinated at the same time. On scraping there was bleeding along the lines of scarification. Area A, no redness or swelling, the appearance resembling the glycerinated area, save that the dry scales were more marked. On scraping there was some bleeding along the lines of scarification. Area B, definite slight redness and swelling ; the lines of scarification were showing up well ; the scabs were quite double the amount from area A ; a moderate raw surface was left on scraping. Area C, decided redness and swelling ; the lines of scarification were filled with vesico-pustules almost continuously. A typical raw surface as after ordinary vaccinia was left on scraping. Area D, resembled area C, but the lines were less full of vesico-pustules. A moderately raw surface was left on scraping.

November 13 : Glycerinated area, nil. Area No. 1, slight scabs in places, Area No. 2, scabs which were easily removed. Area A, nearly normal in appearance. Area B, slight scabs in places, also vesico-pustules, area slightly red. Area C, covered all over with scabby crusts, slightly œdematous. Area D, covered with scabs, red.

November 14 : Glycerinated area : This area had been scraped on November 11 ; it now showed a few scattered minute vesico-papules, probably the result of inoculation at that time. Area No. 1, about eight scattered, large, scabby papules with slight redness and swelling. Area No. 2, flaky, heaped-up yellow scabs with swelling and redness ; in the groin opposite this area there were a few scattered typical vesico-papules, such as occur in vaccinia. Area A, nothing definite, possibly slight swelling. Area B, some redness and swelling with yellowish and blood-tinted scattered scabs. Area C, a thick yellow scab, moist underneath, considerable redness and swelling round the area. Area D, scab marked, but less thick than in C. The belly wall round areas C and D was markedly œdematous, pitting deeply on pressure.

November 17 : Redness and swelling had disappeared, though a heaped-up crust still remained.

On 24th November, these three first calves were again subjected to inoculations as follows :—In each animal a small area was inoculated with seed "C" of the second remove ; another small area with a mixture of seed "C" and "D" of the third remove ; and a third area was scarified but not inoculated.

November 28 : Calves 1 and 2 showed all three areas treated covered with some dry, brownish, scaly scabs, without any pus formation. There seemed no difference between the control areas and the others, and there was, further, no definite "take." Calf 3 showed a slightly more definite exudate over the two variolated areas. It may be noted that on this calf pus from the previous vaccination was still adherent.

December

December 11: A further series of inoculations were made, comprising the three original calves and a fresh one; the results were as follows:—

Calf 1: This calf had a small area in the middle line in front of the scrotum inoculated with a variola vaccine comprising "A," "B," "C" and "D," which had been obtained from Calf 3. These strains had been kept separately until mixed before applying them to the third calf. Between this area and the umbilicus was a scarified area, which acted as a control.

December 16: The new variolated area showed thick crusts, leaving a reddish area on scraping. The outer control area also showed thickish crusts, but these left a smooth area on scraping. The old areas from the previous experiments were quite smooth, By 22nd December, the newly inoculated area and the control area were both quite smooth. as were the old previously inoculated areas, whose situations could be just made out, though there seemed to be no actual scars.

Calf 2: This calf was treated similarly to Calf 1.

December 15: The newly inoculated area showed dry, yellow, adherent scabs, leaving a slightly moist area underneath when removed. The control area showed some dry scabs, which were easily scratched off. The old area last inoculated showed heaped-up thick scabs, whilst the areas treated before these were almost clean. At this time in addition the calf exhibited an exceedingly dry, raised, scabby area round the left eye; three heaped-up areas the size of a shilling on the forehead, and similar areas on the left foreleg; near the knee on both hind legs, several; behind the head, one; on the neck, three; and along the back, several. In these areas spores of a ringworm were detected.

December 22: The newly inoculated area showed heaped-up yellow crusts which were adherent, and left a slightly raw surface on removal. The crusts present were decidedly less than in the case of Calf 4 detailed later on, but indicated an obvious "take." The control area showed at one corner, a small adherent heaped-up crust. This was probably an accidental inoculation of the wound. The old previously inoculated areas were quite clean, and could be recognised by slight scarring.

Calf 3: This calf was also treated similarly to Calf 1.

December 15: The newly inoculated area showed dry scabs following the lines more especially of the scarification. There was doubtful slight œdema and infiltration. The control area showed a few dry scabs much less marked than in the newly inoculated area. Two of the old previously inoculated areas above the umbilicus showed dirty, raw, heaped-up dry scabs still present. Two other old areas still showed some slight scabs. In addition, at this time there were heaped-up dry crusts, leaving a slightly moist area usually about the size of a shilling on removal, on the left hind leg about six; on the right side, several; on the right shoulder, one; the upper lip, one; on the ridge of the back, two. These were due to ringworm.

December 22: The newly inoculated area was almost quite clean. There was no obvious scarring. The old areas were also almost quite clean, though a few flakes were present in places. There was obvious scarring of a superficial kind.

Calf 4: This calf was inoculated on 11th December as follows:—

1. Posterior part of the abdomen, left side; a mixture of "C" and "D" (mixed after removal from the last calf).
2. A similar area on the right side with mixed variolated seeds after passing through two calves.
3. Above and to the right of the umbilicus: Seed "A" third remove.
4. Below and to the right of the umbilicus: Seed "B" third remove.
5. Above and to the left of the umbilicus: Seed "C" third remove.
6. Below and to the left of the umbilicus: Seed "D" third remove.
7. Below the umbilicus in the middle line a scarified control area.

December 15: Areas 1 and 2 showed thickish yellow crusts along the lines of scarification, with redness and slight swelling. There were numerous typical vesico-pustules in both groins. Areas 3, 4, 5, and 6 showed fine scabs with definite slight redness and swelling. These conditions were most marked in 6. 7, the control area, showed some dry yellow scabs easily removed, which left a smooth surface; there was no redness or swelling. On this date the various inoculated areas were scraped.

December 22: All the inoculated areas were now covered with thick yellow crusts which were adherent, and left a slightly raw surface on removal. The œdema had disappeared, and there was only slight swelling now present. The pustules on the groins were dry and scabby.

On 17th December it was decided to try the effect of revaccinating a calf which had been heavily inoculated with vaccinia for the purpose of preparing calf vaccine. This animal had been vaccinated on 24th November with Seed 27, showing five complete rows on the vaccinated area. These rows extended from above the umbilicus almost to the posterior part of the body and each one was about 1½ inches in width. The calf had been scraped for vaccine pulp on 28th November, when a fair yield was obtained. This was rather dry and scaley, except in the stifles. On 17th December it was revaccinated with Seed 76 over a small area on the side, opposite the umbilicus,

December

December 22.—There was no redness or swelling in the new area, which was covered with a thin yellow crust which could be easily scraped off, leaving a smooth surface. The old scars of vaccinia were for the most part smoothed off; in places there were still some dry heaped up crusts which, however, left a smooth surface on removal. There was evidently no definite "take" for the second inoculation of vaccinia.

On 30th December it was decided to see whether the four cases as far as experimented with were resistant or not to vaccinia. A small area about 3 inches long and 1½ inches wide was therefore scarified on the back part of the abdomen in each calf and inoculated with vaccine.

On 2nd January, 1914, the following results were obtained: –

Calf 1.—Definite, slightly adherent, heaped-up scabs. The lines of scarification were definitely heaped up. Slight redness and swelling in places.

Calf 2.—The vaccinated area was covered with a moderately sized, yellow adherent scab. The lines of scarification were well marked with slight redness and swelling. There was evidently a definite slight "take."

Calf 3.—Raised yellowish thick scabs, moderately adherent. There was no œdema but slight swelling. A few typical pustules were seen at the edge of the scarified area.

Calf 4.—The old areas of the last inoculation showed the presence of thick, heaped-up scabs, adherent, leaving almost a clean surface. The new area showed some thin yellow scabs, leaving a clean area underneath. There were no pustules and no œdema or swelling. There had been apparently no "take."

On 9th January, Calf 5 (previously used on 24th November for the preparation of vaccine lymph) was variolated with mixed seed of the fourth remove in the middle line in the front and behind the udder. A control area in which glycerine and water alone were used was scarified on the right side, as well as a small area on the right groin. On examination, four days later, there were slight yellow scabs easily rubbed off in front of the udder, whilst behind the udder yellow scabs were more apparent. There had evidently been a slight "take." The control areas were practically free from scabs.

On 15th January, a further calf, No. 6, was variolated with the fourth remove over a large area of the abdomen amounting to about 50 square inches. By 19th January there was a good "take" with marked pustules and scabs, and typical vesico-pustules in both groins due to accidental infection of scratches. The "take" in this case was indistinguishable from that which obtains in ordinary vaccinia.

On 22nd January Calf 5 (originally used for preparation of vaccine lymph and variolated on 9th January), and Calf 6 (variolated with the fourth remove on 15th January), were re-vaccinated with ordinary calf lymph. On 6th February, the following results were obtained:—

Calf 5. No "take." The inoculated area was quite clean except for some easily removed yellow scabs at its lower part.

Calf 6 showed slightly adherent yellow crusts, which gave slight bleeding on removal and slight induration. There were no definite pustules. The condition presented suggested a slight "take," but nothing to be compared with the result in a further calf vaccinated on the same date.

Calf 7. On 27th February, seed from Calf 6 was inoculated over a large area (seven broad bands) of the abdomen of Calf No. 7. Four days later there was a marked typical reaction as in ordinary vaccinia with vesico-pustules and scabs together with œdema and slight redness. The scabs were dry on the upper part of the abdomen but softer in the groins. The pulp was removed, 40 grammes being obtained.

Macaque Monkeys.

The following inoculations have been made for the purpose of testing the variola lymph on monkeys:—

On 15th November, Monkey No. 1 was variolated on the arm, as is done in vaccinating children, over three areas with lymph of the third remove. On two of these areas more or less pure strains from two of the patients were used respectively, and over the third area a mixed strain from the four. On 20th November it was noticed that the monkey had been off food for the last day, the inoculated areas had been irritable, and scratching them seemed to soothe the animal. One of the areas inoculated with lymph obtained from one patient showed œdema and slight swelling around a papule covered with a scab. There were small secondary papules around this area. The other area inoculated with the strain from a second individual patient showed a less marked swelling and a few small papules around. The area inoculated with the mixed strains showed a less definite reaction and no secondary papules. Two days later the areas were

covered

covered with scabs with slight induration around, the appearances resembling those seen in a definite but not severe "take" in a child. It will be noted that the reaction occurred earlier than in human beings.

On 22nd January Monkey No. 1 and another monkey, No. 2, were each vaccinated with ordinary calf lymph over three areas, Monkey No. 1 being done on the opposite arm to that previously variolated. The following results were shown on 30th January :—

Monkey No. 1.—Two of the three areas showed normal skin. The third area showed a yellowish-brown mulberry reaction the size of a threepenny piece, with no indurated base and no redness.

Monkey No. 2.—The three areas showed large yellowish brown heaped-up scabs on a definite indurated base with slight œdema and swelling around the areas and definite redness.

III.—PREPARATION OF CALF LYMPH.

(J. B. Cleland and E. W. Ferguson.)

At the beginning of July, 1913, a widespread epidemic of a remarkably mild type of smallpox appeared in Sydney amongst a population, to a very great extent, unprotected by vaccination. The interference with commercial pursuits, and the necessary detention of cases for a considerable period in quarantine, together with the disfigurement of those affected with a copious rash, created a phenomenal demand for vaccination amongst the community. This demand, running into several thousands a day, followed within a few hours of the announcement of the presence of the epidemic in Sydney, and the authorities were somewhat handicapped in obtaining an immediate quantity of lymph sufficient to cope with it. At an early stage it was recognised that it would be advisable to supplement the Commonwealth supply by a special local production for the use of the State. This matter was at once proceeded with, a suitable building was located, and the Director of Quarantine kindly supplied some seed lymph for the purpose.

The building chosen for a temporary lymph farm was portion of the recently-completed, and as yet unoccupied, penitentiary at Long Bay. Through the kind offices of the Director-General of Public Works and the Comptroller-General of Prisons, portion of this establishment was placed in our hands. The rooms occupied by the calves were intended later to be used as bathrooms at the penitentiary, and were as suitable, with the short time at our disposal, as any we had hope of securing. The floors were cemented, and the upper walls kalsomined, iron partitions separating individual bath spaces.

It is proposed to go somewhat fully into the details of the preparation of calf lymph under these urgent circumstances, as such may be a guide to officers similarly situated to ourselves should future emergency of the same kind arise, and the officers concerned have had no recent experience of a practical kind in the preparation of calf lymph on an extensive scale.

The calves chosen were usually from four to eight months old. Their condition was as good as could be obtained, and any showing evidence of unsoundness were rejected. Post-mortems were held on all as soon after the removal of the lymph as circumstances permitted, and in those cases where the evidence of disease appeared—remarkably few, it may be noted—the lymph was then destroyed. It was impossible to feed up the calves beforehand so as to get them into the "pink" of condition, as time did not allow of this. Before being vaccinated, each calf was carefully groomed ; the whole of the abdominal surface, from the level of the lower end of the sternum, and the inner surfaces of the thighs, were then shaved and washed, the calf being placed on a special lymph table made for us by Mr. Andrew Thom, of Sydney. The table was of the usual form, capable of being slung on the side, thus allowing the calf to be strapped on, and then tilted into position. The legs were of galvanised piping, and the table top of wood completely covered with tinned copper sheeting, so as to be capable of thorough cleansing. After shaving, the abdominal surface of the calf was thoroughly scrubbed with hot boiled water and soap, then rinsed with hot boiled water, and finally washed with spirit. Then by means of a short-pronged heavy rake about an inch broad, lines of linear incisions were made in the lower part of the washed area, to or above the umbilicus, the skin being held taut by a flat metal instrument. The abdominal surface was scarified in this way, usually by six to eight series of these linear areas. Frequently a short scarified area was also placed in each groin. The incisions were just sufficiently deep to show a definite, thin, red line, bleeding being as far as possible avoided. Seed lymph, consisting of pulp emulsified in sterilized 50 per cent. glycerine (equal parts by weight of pulp and glycerine solution) was then worked into the fine linear incisions by means of small human vaccine scarifiers. These instruments were so used as not only to fill the linear incision with lymph, but also to make additional fine scarifications. After this procedure, the area was allowed to dry slowly as far as the presence of glycerine would permit. A clean buttercloth covering was next applied and tied on top round the animal's back and legs. This was covered again by a sheet of unbleached calico. The animal was now returned to a clean stall bedded with fresh clean hay. At one period the calves were kept in pens composed of galvanised piping, being tied by short halters ; it was later, however, found that they could be kept cleaner by tying each

each one separately in one of the small bathroom spaces. The attendant carefully looked after the calves by day and during the evening, and slept on the premises, his duty being to see that droppings were immediately removed, that the dressings were in position, and that soiling of the vaccinated area was prevented. After vaccination the calves were fed upon oaten chaff and lucerne hay, with a little bran. Lucerne chaff on one or two occasions led to scouring, and had to be abandoned. Unfortunately, milk was unobtainable to feed the animals on, as its use might have given better results. At the end of four days the calf was returned to the operating room ; the bandages were removed and the vaccinated area well irrigated with hot boiled water, any extraneous matter being carefully removed by cotton-wool swabs. After thorough cleansing in this fashion, hot towels were applied, and thereafter the vaccine pulp was removed by means of a scoop and forwarded to the Laboratory, where it was weighed and emulsified with glycerine. The washing with hot water and the application of hot towels brought out in relief the inoculated areas.

The Appearance of the Vaccinated Areas.—Individual calves varied considerably in the appearances presented, even when done at the same time with exactly the same strain of lymph. Sometimes the whole area yielded a yellowish, buttery pulp, and at other times the reaction was remarkably dry and scaly. In nearly all instances the tender skin on the thighs and near the udder yielded a fairly soft exudate, whilst near and in front of the umbilicus the tendency was for the material to be dry. It was thought at one time that the general condition of the calf had much to do with the appearance of the vaccinated area, and to some extent this holds good, calves with thin skins and tense bellies yieding a more buttery exudate. Speaking generally, however, one could never be sure from the appearance of the calf before vaccination what kind of exudate would be yielded. The amount of pulp removed varied from about 12 grammes up to nearly 77 grammes, the latter being obtained from buttery exudates with a considerable amount of reaction on the part of the calf. That such a high yield of a buttery exudate could furnish a calf lymph of excellent quality and potency is evidenced on reference to Calf No. 83 in the table. This animal yielded an amount of lymph sufficient to vaccinate 21,900 people, a portion being also reserved for seed.

Treatment of the Pulp.—The pulp, after removal, was forwarded, surrounded by ice, to the laboratory, where it was at once mixed with equal parts of sterilised 50 per cent. glycerine. After allowing it to soak in this solution for twenty-four to forty-eight hours the mixture was thoroughly triturated in an electrically driven lymph machine (a hand machine was used at first). Portion of the ground up material was then kept as seed lymph, and the rest was further diluted to the extent of one to five with 50 per cent. glycerine solution and stored in the cold.

Bacteriological examinations made of the various lymphs immediately after trituration showed invariably a number of colonies of *Staphylococcus aureus* and *albus*. In some lymphs there were in addition *Staphylococcus epidermidis albus* and colon bacilli ; sporers were also present, *B. mesentericus* occasionally appearing. After storing in the cold the number of organisms gradually and then rapidly diminished, some lymphs being sterile in a fortnight and others not so until at the end of a month. Sporing organisms as well as non-sporers disappeared on exposure to the glycerine. When the lymph was bacteriologically sterile it was then issued. Attempts were made at shortening the period necessary to eliminate germs by the glycerine method, by subjecting some samples to the passage of chloroform vapour. This method, however, did not prove so successful, although the lymph could be rendered free from bacteria in fifteen minutes, the results obtained by using such lymphs being unsatisfactory.

The results of the use of the calf lymph.—As far as possible our lymphs were tested as to giving a typical reaction before being used for wholesale vaccination. Unfortunately, it was difficult in many cases, when the rush was at its height, to obtain unvaccinated persons, who could be kept under observation, on whom to test the lymph. Many strains had therefore to be used before they could be tested as to their efficiency, and in a number of cases the vaccination was mild or abortive, and the cases had to be revaccinated with a better lymph. We have not been able to ascertain exactly why the lymph obtained from some calves gave excellent reactions, while that from others failed completely or in part. We are not at present prepared to say whether these irregular results were due to the strain of lymph employed, to our method of preparation, or to the impossibility of testing every strain sufficiently before it was necessary to use it, or whether the preparation and storage of the lymph in a warm climate led to its early deterioration. It has recently been pointed out that enzyme action may possibly play a part in the rapid deterioration of lymph, especially in warm climates. If numerous leucocytes are present in the pulp, the ferments produced by them would presumably be little affected by the glycerine used for the purpose of eliminating the bacteria. Possibly such enzyme action might have a remarkably deteriorating effect upon the vaccine virus itself. It is interesting to note that the untreated pulp was alkaline to sensitive litmus paper.

We put on record these facts as regards the variability of the lymph with which we worked as they may be of help to others. We have not been able to find in the literature at our disposal as regards vaccine establishments elsewhere, any reference to such difficulties as these, and are therefore unaware whether they are peculiar to our own methods, or have merely not received mention by others.

Preparation of Calf Lymph.

No.	Age in Months.	Condition of Animal.	Vaccinated Date.	No. of Seed Used.	Character of Take.	Pulp Removed.	Weight of Pulp in Grammes.	Post-mortem of Animal.	Distribution of Lymph.	Vaccination Results.	Remarks.
1	4	Poor	1913. 12 July	Melbourne seed	Abundant exudate, confluent	1913. 16 July	13·0 (about).	Normal	{ Lymph from these calves (Nos. 1 and 2) treated with $CHCl_3$ vapour. }	Poor.	
2	6	„	13 „	„	„ „	17 „	17·2	„		„	
3	4	„	16 „	„	Not all scratches taken, yellow pustules, some blood stained.	20 „	27·1	„	6,800 doses with $CHCl_3$; 9,200 doses glycerine.	Reaction mild.	
4	3½	„	17 „	„	Mildly in linear rows; in places not taken.	21 „	29·3	„	6,200 doses glycerine	„ „	
5	2	„	17 „	„	Taken incompletely; nice vesico-pustules.	21 „	17·3	„	33 tubes glycerine; 5,000 doses glycerine. 1 tube = 10 doses.	Reaction poor.	
6	3	„	18 „	Melbourne seed; seed very thin.	No data	22 „	16·0	„	100 doses $CHCl_3$; 2,900 doses glycerine.	Reaction good.	
7	3½	Medium...	18 „	„ „ ...	Poor yield; seed used very thin...	22 „	12·0	„	6,800 doses glycerine	No data.	
8	3	Poor	20 „	No. 2 glycerine; No. 2 $CHCl_3$.	No. 2 glycerine taken only fairly; vesicles not large. $CHCl_3$ very slightly taken.	24 „	9·5	„	3,100 doses glycerine	„	
9	4	Fair	20 „	No. 1	Taken moderately well all over; vesicles small.	24 „	25·0	T.B. in bronchial glands and three areas in lung tissue.	Destroyed.		
10	3½	„	20 „	No. 1 glycerine; No. 2 glycerine; No. 2, $CHCl_3$.	Taken uniformly well.....	24 „	27·0	Normal	600 tubes glycerine; 3,200 doses glycerine.	No data.	
11	4	„	22 „	No. 1 glycerine; No. 2 glycerine.	Vesico-pustules poor all along; yellow crusts.	26 „	9·5	„	268 tubes glycerine; 100 doses glycerine.	„	Very thin skin, veins prominent.
12	4½	Good	22 „	No. 2 glycerine	Eruption well up; confluent yellowish patches.	26 „	26·5	„	348 tubes glycerine	„	Good skin.
13	4½	Fair	23 „	No. 3 glycerine	Eruption well up in places, confined to lines.	27 „	27·7	*Strongylus* in left lung, otherwise sound.	5,000 doses glycerine	„	
14	6½	„	23 „	No. 1.....	Taken well on right rows, poor on left.	27 „	19·5	Normal	Seed only.		
15	3	„	24 „	No. 4.....	Pulp very dry	28 „	24·0	„	5,400 doses glycerine	„	99 hours.
16	4	„	24 „	No. 7.....	Pulp dry	28 „	26·0	This calf had red-water...	Destroyed	.....	„
17	4	Good	25 „	No. 5.....	Pulp good, buttery	29 „	45·7	Small lobe left lung slightly hepatised, ? parasitic. Otherwise sound.	9,200 doses	Reaction fair.....	93½ hours.
18	3½	Fair	25 „	No. 4.....	Pulp very dry	29 „	28·3	*Strongylus* in both lungs, otherwise sound.	5,800 doses	No data	97¼ hours.
19	5	„	25 „	No. 6.....	No data	30 „	18·5	Normal	7,400 doses	„	
20	7	Good	26 „	No. 2	Best conditioned calf so far; no data of take.	30 „	27·0	„	555 tubes; 1,900 doses	Reaction good.	
21	3	Medium...	28 „	No. 9.....	No data	1 Aug.	19	*Strongylus* in lungs, otherwise sound.	Seed only.....	.....	96 hours
22	6	Fair	28 „	„	No data	1 „	19·0	Normal	„	.....	95¼ hours.
23	5	„	29 „	No. 4	Taken moderately well	2 „	18·0	Mesenteric glands œdematous, otherwise sound.	„		
24	5	„	30 „	No. 12	No data	3 „	33·3	Normal	492 tubes; 4,900 doses	Reaction fair.	
25	8	„	1 Aug.	No. 10	Fairly good yield; trifle dry	5 „	32·0	„	5,100 doses	No data.	
26	4	„	1 „	„	Good; dry in places	5 „	33·0	„	Seed only	.....	97¼ hours.

Preparation of Calf Lymph—*continued.*

No.	Age in Months.	Condition of Animal.	Vaccinated Date.	No. of Seed Used.	Character of Take.	Pulp Removed.	Weight of Pulp in Grammes	Post-mortem of Animal.	Distribution of Lymph.	Vaccination Results.	Remarks.
			1913.			1913.					
27	4	Fair	2 Aug.	No. 12	Very good; flaky yellow crusts well up.	6 Aug.	36·5	Found dead; post-mortem, neck dislocated.	Seed only	.....	93 hours.
28	5	„	2 „	„	Good yield; rather dry	6 „	43·0	Found dead in paddock; post-mortem, pleuro-pneumonia.	Destroyed.		
29	8	„	5 „	No. 14	Good yield; dry in places.....	9 „	41·5	Normal	Seed only	.....	97 hours.
30	6	„	5 „	„	Good yield; soft and buttery	9 „	44·5	„	9,300 doses	Reaction good ...	94½ hours.
31	6	.....	7 „	No. 17	Yield fair; rather dry	11 „	32·5	„	Seed only	.....	95½ hours.
32	8	„	7 „	„	Yield fair; rather dry	11 „	26·0	„	Seed; 100 doses	Reaction fair ...	96 hours.
33	8	„	7 „	„	Yield good; buttery	11 „	68·5	„	713 tubes; 8,400 doses.....	Reaction very good.	94½ hours.
34	4½	„	8 „	No. 6	Yield dry and stringy.....	12 „	36·0	„	Seed only	.....	95½ hours.
35	5	„	8 „	„	Yield good; buttery	12 „	63·5	„	39 tubes; 14,900 doses.....	Reaction very good.	95½ hours.
36	7	Good	9 „	No. 16	Yield dry and stringy.....	13 „	35·5	„	Too hard for milling.	.....	94½ hours.
37	7	„	11 „	„	Yield fairly good; slightly dry in patches.	15 „	38·5	„	8,000 doses	Reaction very good.	95½ hours.
38	7	„	11 „	„	Yield fair; rather dry	15 „	45·0	„	306 tubes ; 5,200 doses.....	Reaction very good.	96½ hours.
39	5	Fair	14 „	No. 13	Pustules practically dried up; useless.	18 „	19·5	„	Seed only	.....	98½ hours.
40	6	„	14 „	„	Yield good; ? buttery	18 „	67·0	„	1,113 tubes; 7,500 doses	Reaction typical	98 hours.
41	6	„	15 „	No. 20	Yield fairly good, a trifle dry in places; buttery.	19 „	26·0	„	Seed only	.....	93 hours.
42	5	„	15 „	„	Yield fair; buttery	19 „	34·5	„	4 tubes; balance 50 doses seed.....	Reaction mild ...	93 hours.
43	10	„	18 „	No. 15	Pustules good; buttery; yield moderate.	22 „	30·0	„	4 tubes; 50 doses for testing.....	Reaction poor to mild.	95 hours.
44	9	„	19 „	No. 13	Yield good; somewhat buttery ...	23 „	53·5	„	6 tubes; 50 doses for testing	„	96 hours.
45	5	„	19 „	„	No data	23 „	42·5	„	4 tubes; 1,600 doses for testing ...	„	94½ hours.
46	6	„	21 „	No. 18	Yield fair; rather dry	25 „	26·5	*Strongylus* in both lungs, otherwise sound.	50 doses for testing	Reaction nil	96 hours.
47	6	„	21 „	„	Yield fair; slightly dry	25 „	34·0	Normal	50 doses for testing.....	„	„
48	6	„	21 „	„	Yield fairly good; slightly dry	25 „	30·5	*Strongylus* in right lung, otherwise sound.	„ „	„ ...	93½ hours.
49	8	„	22 „	„	Matured early; yield poor and dry...	25 „	14·0	Normal	Seed only	.....	75½ hours.
50	8	„	22 „	„	Yield fair; rather dry	26 „	28·5	*Strongylus* in both lungs, otherwise sound.	4 tubes; 50 doses for testing	Reaction nil	94½ hours.
51	5	„	23 „	No. 15	Matured late; yield poor but soft...	28 „	22·0	Normal	Seed only	.....	111½ hours.
52	7	„ (?)...	25 „	No. 21	Yield very dry	29 „	30·0	Slight pleurisy, two broken ribs (old breaks), diarrhœa, otherwise sound.	„	.....	98½ hours.
53	7	„	25 „	„	Yield very dry and scaly	29 „	31·5	Normal	150 doses for testing	Reaction poor ...	98½ hours
54	6	„	26 „	„	Moderately soft; yield fair but not buttery.	30 „	32·5	„	„ „	Reaction mild ...	96½ hours.
55	6	„	26 „	„	Yield good; buttery	30 „	36·5	„	„ „	„ ...	96½ hours.
56	7	„	28 „	No. 22	Yield poor and dry.....	1 Sept.	26·0	„	Seed	.....	98½ hours.

No.	Age in Months.	Condition of Animal.	Vaccinated Date.	No. of Seed Used.	Character of Take.	Pulp Removed.	Weight of Pulp in Grammes.	Post-mortem of Animal.	Distribution of Lymph.	Vaccination Results.	Remarks.
			1913.			1913.					
57	6	Poor	28 Aug.	No. 22	Yield poor, good in few places, elsewhere stringy.	1 Sept.	21·0	Normal	Seed	.....	97½ hours.
58	6	Fair	29 „	No. 33	Pulp dirty; yield moderately good	2 „	33·0	No disease; animal poor	„	.....	
59	6	„	29 „	„	Yield moderate; flaky to buttery...	2 „	30·0	No disease; animal poor	6 tubes, 1,600 doses	Reaction nil.	
60	5	„	30 „	No. 23	Yield fair; somewhat dry	3 „	No pulp saved.	Animal died; post-mortem lungs showed alternate areas of congestion and collapse; broncho-pneumonia; no T.B.; tapeworm in small gut.	Destroyed.		
61	6	„	30 „	„	Yield fair; buttery to dry	3 „	32·0	Died 5 Sept., 1913; no disease apparent; in very poor condition.	Seed only.		
62	10	Good	1 Sept.	„	Yield good; inclined to be scaly ...	5 „	43·0	Normal; fair	6 tubes for testing	Reaction poor ...	96 hours.
63	10	„	1 „	„	Yield good; soft.....	5 „	36·0	„ „	Seed	.....	96 hours.
64	7	Fair	2 „	No. 30	Yield good; buttery to dry.....	6 „	62·0	„ „	6 tubes for testing	Reaction poor ...	95½ hours.
65	5	„	4 „	No. 35	Yield good; buttery to dry	8 „	40·0	Normal; very poor.....	„	Reaction fair ...	96 hours.
66	8	„	4 „	„	Yield fair; slightly dry	8 „	32·0	„ „	2 tubes for testing	No data	95½ hours.
67	8	„	4 „	„	Yield good; buttery to slightly stringy.	8 „	68·0	Normal; fair	1,031 tubes, 2,850 doses	Reaction typical but violent.	96 hours.
68	7	„	5 „	No. 25	Yield poor; dry and stringy.....	9 „	24·5	Normal; very poor	Seed	.....	96½ hours.
69	4	Poor	5 „	„	Yield very poor	9 „	11·0	„ „	„	.....	96½ hours.
70	8	Fair	6 „	No. 33	Yield fairly good.....	10 „	31·0	Normal; medium	6 tubes for testing	Reaction mild ...	96 hours.
71	8	„	6 „	„	Yield good; buttery	10 „	56·0	Normal; poor	„ „	Reaction poor ..	95½ hours.
72	6	„	8 „	No. 40	Yield good; buttery, strong odour	12 „	35·5	„ „	414 tubes, 1,500 doses	Reaction good ...	97½ hours.
73	6	„	8 „	„	Yield good; buttery	12 „	51·5	„ „	6 tubes for testing	Reaction fair ...	94½ hours.
74	9	„	9 „	No. 45	Yield good; in good condition.....	13 „	43·0	„ „	Seed	.....	91½ hours.
75	9	„	9 „	„	Yield fair; soft to dry	13 „	51·0	„ „	3 tubes for testing	Reaction nil	92½ hours.
76	8	„	12 „	No. 26	Yield good; buttery to dry	16 „	60·5	Normal	2 tubes for testing	Reaction nil ...	94 hours.
77	8	„	12 „	„	Yield good; buttery	16 „	44·0	„	Seed	.....	93½ hours.
78	7	„	15 „	No. 29	Yield good; buttery to dry.....	19 „	39·0	„	1 tube; 1,600 doses	No data	96½ hours.
79	6	„	15 „	„	Yield good; rather dry	19 „	42·5	„	Seed	.....	95½ hours.
80	10	Good	18 „	No. 30	Yield large; dry and scaly	22 „	46·0	„	2 tubes for testing	Reaction nil ...	93½ hours.
81	6	Poor	18 „	„	Yield good; buttery	22 „	39·0	„	Seed	.....	93½ hours.
82	8	Good	19 „	No. 41	Yield large but dry	23 „	48·5	„	„	.....	96½ hours.
83	8	Fair	19 „	„	Yield good; buttery to crusty	23 „	77·5	„	1,452 tubes, including 100 tubes for seed; 7,380 doses.	Reaction typical	96 hours.
84	8	Good	22 „	No. 29	Yield good; buttery	26 „	51·0	„	Seed	Not tested	93½ hours.
85	7	Fair	22 „	„	Yield poor and dry.....	26 „	29·5	„	„	„	93½ hours.
86	7	„	26 „	„	Yield very small and dry	30 „	5·0	„	„	„	94½ hours.
87	10	Good	26 „	„	Yield moderate; dry and crusty...	30 „	17·0	„	„	„	93½ hours.
88	6	Poor	29 „	No. 38	Yield small but good	3 Oct.	14·0	Small abscess in spleen ...	Destroyed	.....	95½ hours.
89	6	„	29 „	„	Yield poor and dry	3 „	6·0	Normal	Seed	Not tested	95½ hours.
90	6	Fair	3 Oct.	No. 37	Yield moderate and dry.....	7 „	19·0	„	Seed, 2 tubes	Reaction nil	96½ hours.

Preparation of Calf Lymph—*continued.*

No.	Age in Months.	Condition of Animal.	Vaccinated Date.	No. of Seed Used.	Character of Take.	Pulp Removed.	Weight of Pulp in Grammes.	Post-mortem of Animal.	Distribution of Lymph.	Vaccination Results.	Remarks.
			1913.			1913.					
91	6	Poor	3 Oct.	No. 37	None	.....	.....	Animal had diarrhœa, very sick; post-mortem, enteritis and congested lungs.	Destroyed.		
92	7	Fair	9 „	No. 38	Yield large; crust in fairly good condition but adherent.	13 Oct.	41·0	Normal	2,600 doses	Reaction good ...	96½ hours.
93	6	„ ...	9 „	„	Yield good and buttery	13 „	45·5	„	2 tubes; 1,600 doses	„ ...	96½ hours.
94	8	Poor	13 „	No. 75	Yield good and buttery	17 „	40·5	„	360 tubes; 2,300 doses	Reaction poor ...	96½ hours.
95	6	Fair	13 „	„	Yield poor and crusty	17 „	23·5	„	Seed	Not tested	97 hours.
96	8	„	20 „	No. 67	Yield fair, all the lines taken.....	24 „	29·0	„	145 tubes; 50 doses	Reaction poor ...	97 hours.
97	6	„	27 „	„	Yield good; crusts adherent to dressings.	31 „	35·5	„	1 tube for testing	No data	95½ hours.
98	8	„	3 Nov.	No. 89	Yield good; buttery and crusts adherent.	7 Nov.	48·0	„	1 tube for testing; 300 doses.....	Reaction mild ...	95 hours.
99	10	Good	10 „	No. 67	Yield fair but buttery	14 „	23·0	„	2 tubes for testing	Reaction nil	96½ hours.
100	9	„	17 „	No. 41	Yield moderate but dry.....	21 „	29·5	„	.....	Not tested.	
101	6	„	24 „	No. 27	Yield fair; dry and scaly	28 „	34·5	„	16 tubes for testing.....	Reaction nil.	
102	6	Poor	2 Dec.	No. 72	Yield moderate and dry.....	6 Dec.	26·5	„	.....	Not tested	93 hours.
103	9	Good	8 „	No. 76	Yield poor; dry and scaly	12 „	26·0	„	126 tubes	Reaction nil.	
104	8	„	15 „	No. 83	Yield moderate; good and buttery	19 „	29·0	„	.....	Not tested	97 hours.
			1914.			1914.					
105	8	Poor	19 Jan.	„	Yield poor and dry.....	23 Jan.	21·0	„	.....	„	
106	8	Good	29 „	No. 95	Yield poor but fairly good.....	2 Feb.	17·5	„	.....	„	
107	9	„	2 Feb.	No. 42	Yield poor and dry.....	6 „	23·0	„	.....	„	95½ hours.
108	11	„	9 „	No. 96	Yield poor and dirty	13 „	18·5	„	.....	„	
109	4	„	20 „	No. 82	Yield moderate but good.....	24 „	25·0	„	.....	„	93 hours.
110	4	„	20 „	„	„ „	24 „	21·5	„	.....	„	„

Pulp obtained from 108 of the calves; seed and lymph from 104.

Sydney: William Applegate Gullick, Government Printer.—1915.

Smallpox in Sydney.

Case 341.—Female, aged 14; unvaccinated. Photograph taken on fifth day of rash. Typical mild case.

Smallpox in Sydney.

Case 1,009.—Male, aged, 26; unvaccinated. Photograph taken two months after appearance of rash to show pitting. Severe case.

Smallpox in Sydney.

Case 1,088.—Male, aged 30; unvaccinated. Photograph taken on sixth day of rash.

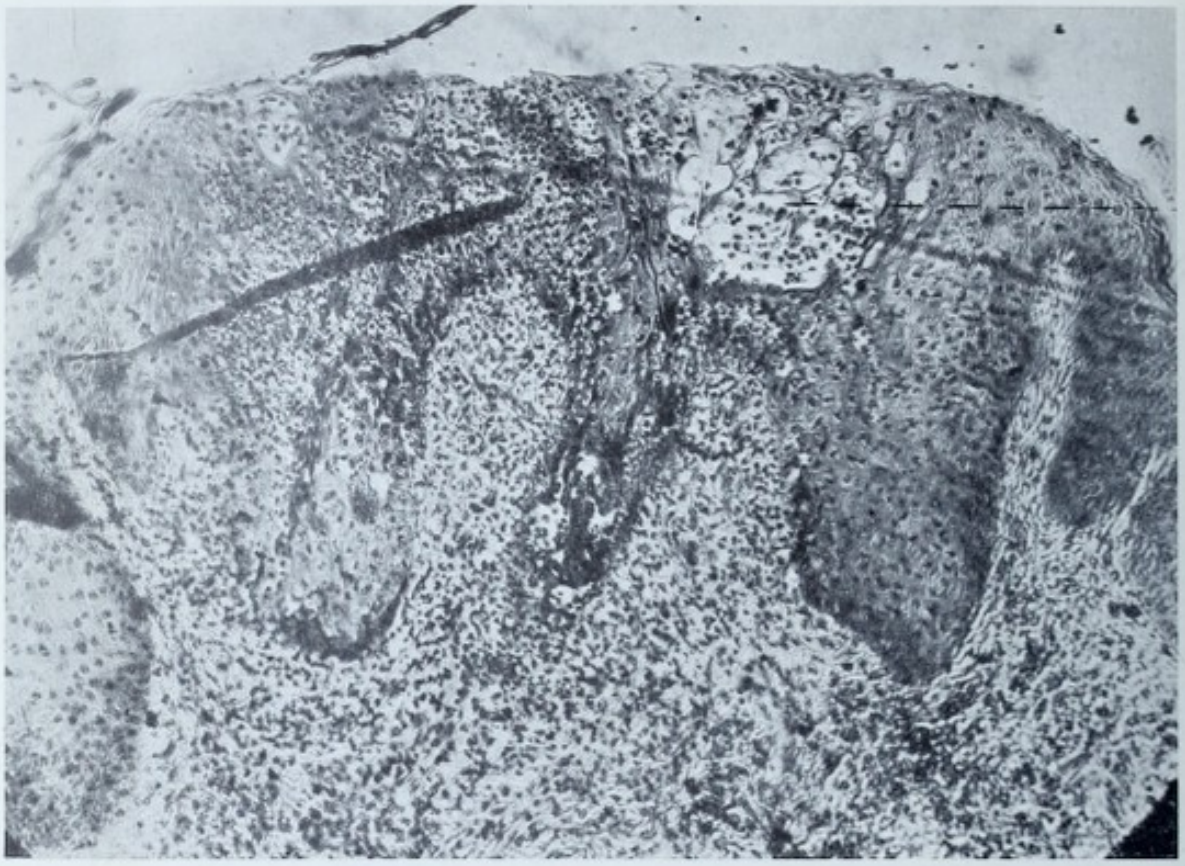

Plate I.—Section through a Smallpox Pustule (Sydney outbreak).

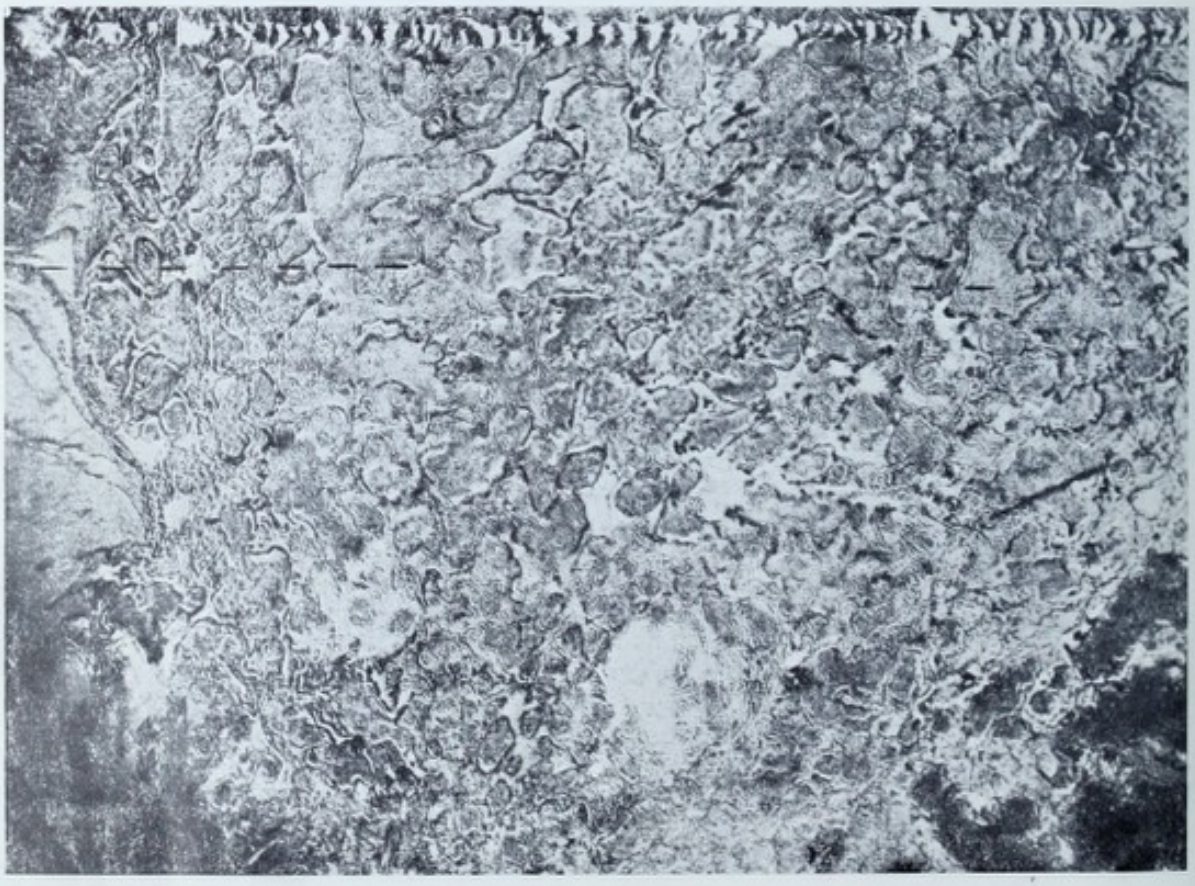

Plate II.—Section through the Placenta, Smallpox (Sydney outbreak).
A.—Areas of cell necrosis. B.—Normal areas.

Plate III.—Section through the Placenta, Smallpox (Sydney outbreak).
A.—Areas of degenerated cells and polymorphonuclear infiltration.

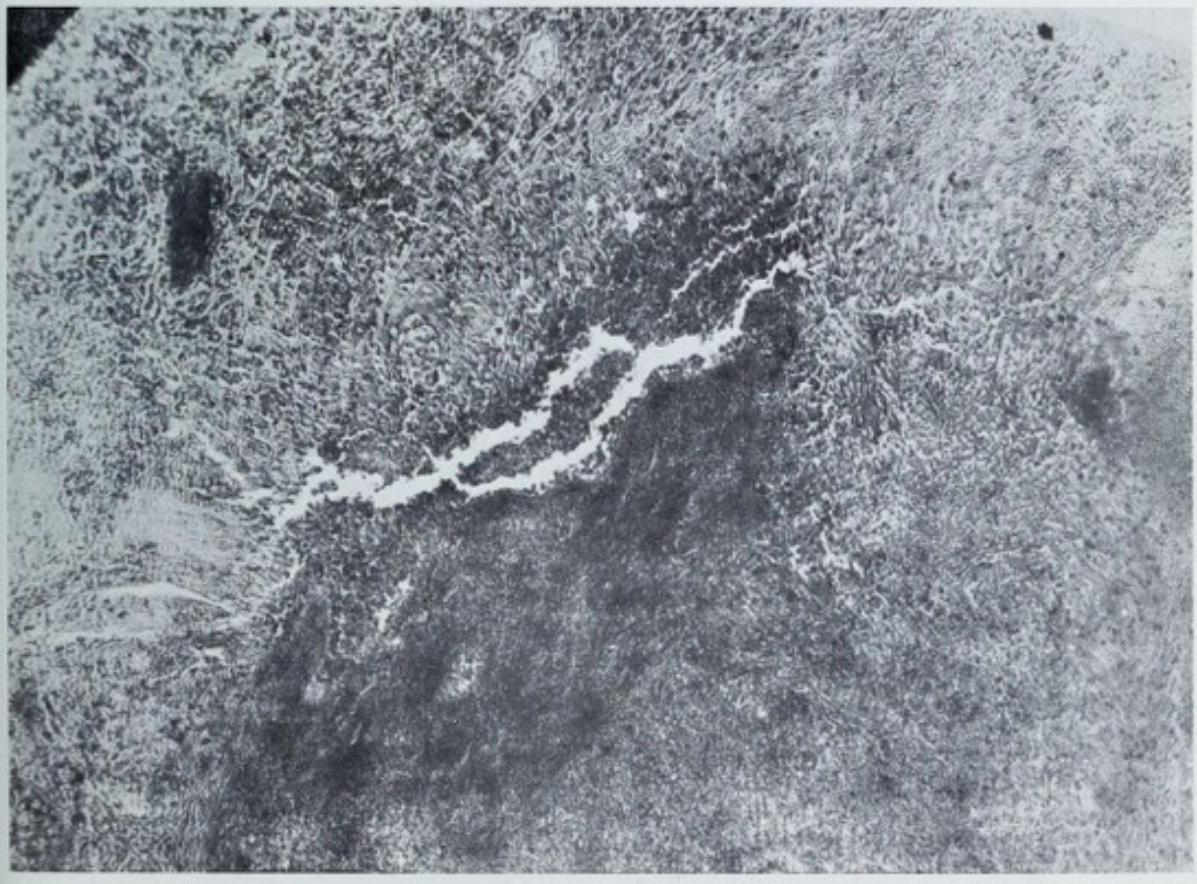

Plate IV.—Section through the Placenta, Smallpox (Sydney outbreak).
Extensive areas of degeneration with polymorphonuclear infiltration.