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SUBJECT.

Studies in Scuroy -

ENCLOSURES.

Thesis for Degree of M.D.
by

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No records emanating from remote antiquity describes Scurvy as it has been known in later times. Thucydides, who has been styled "the greatest historian that ever lived", described the horrors of the plague at Athens (431 B.C.) in words of lurid fire; but, unfortunately, no such writer has left us a description of Scurvy as it existed among the ancients, although we may well believe that the conditions under which they often lived and waged war were favourable to outbreaks of it on a large scale.

The earliest suggestion of the occurrence of Scurvy is, probably, that found in the writings of Pliny; who states that a disease, which was cured by eating a certain vegetable, attacked the soldiers of Germanicus. ⁽¹⁾

A passage in Strabo seems to indicate that it prevailed in the army of Aelius Gallus, in Arabia, in the reign of Augustus. ⁽²⁾

There is evidence, more or less reliable, that, in mediaeval times, it broke out in beleaguered towns and garrisons. It certainly decimated the armies of Louis the 9th of France, during their expedition against the Saracens in the 13th century. It is not, however, until we approach the records of early maritime enterprise that we stumble upon anything like a definite description of its nature and occasional virulence.

The sailors of Bartholomew Dias (1486), Vasco di Gama (1496), Raymond (1591), and Lancaster

Lancaster (1601), in their early voyages round the Cape of Good Hope, suffered, more or less, from Scurvy.^③ excellent accounts of it are to be found in the narratives of such navigators as Jacques Cartier, Dampier, Anson and Captain Cook; while the records of the Seven Years' War bear ample testimony to its ravages in our naval fleets.

Lancaster and Captain Cook, in their longer voyages, proved the efficacy of lemon-juice as a remedy in the disease; and Dampier records, with some enthusiasm, the benefits resulting to his crews from a short stay on the island of Juan Fernandez (1683), where they were fed on fresh vegetables and goats' flesh; - "a regimen which", to use his own words, "proved very beneficial".^④

Anson's account, however, is less glowing; for, when he landed his scorbutic sailors on the same island in 1739, he relates how, although many greatly benefited eventually, "the disease continued unabated for twenty days", and, in some cases, assumed an intractable form.^⑤

The first clear and scientific record of Scurvy is to be found in the writings of Lind (1797), and it is largely due to his insight, and the efforts of Sir Gilbert Blane, that the disease was, by 1810, practically, banished from the Navy and Mercantile Marine.

The facts which it is proposed to record in this paper were derived from observations made by the writer on a large number of cases of Scurvy which were treated in the Military Hospital at Bloemfontein,

O. F. S. during part of the years 1902-03-04.

Two hundred natives, suffering from Scurvy, were treated in No.8 General Hospital during the above-mentioned period, and of this number thirteen died. But, before describing its most striking symptoms, it may be well to pass in brief review the several theories which have been, at different times, advanced in explanation of this disease.

Garrod based his well-known theory - a speculation which has not so far been confirmed - that Scurvy was due to a deficiency of Potassium Salts in the food, upon the analysis of a single case of the disease. Chalvet's observations were derived from the examination of one case, Busk's from that of three, while Bland Sutton has described the post-mortem appearances in two fatal cases, in the Clinical Society's Transactions, 1871.

Ralfe affirmed that Scurvy was due to a deficiency of vegetable acids, such as malates, citrates and lactates, - this deficiency giving rise to diminished alkalinity of the blood.

A view which, for a time, attracted much attention is that which attributes Scurvy to the want of fresh meat rather than of fresh vegetables.

The inference to be drawn from the practical observations advanced in support of this argument is, that Scurvy is actually due to the deleterious effects of Ptomaines ingested in insufficiently preserved meat. Such a suggestion is primarily due to Professor Torup of Christiania; but the actual facts invoked to sustain the view were derived from recent experiences in the Arctic regions.

In an interesting and instructive article

article in the "Practitioner" (1896) Dr. Neale drew attention to the fact that although the crews of the "Alert" and "Discovery", during the Nares Polar Expedition, were daily served with lime-juice, they, nevertheless, suffered from Scurvy. ⁽⁶⁾ On the other hand, he states that, after the loss of the "Eira", the crew spent nine months on Franz Joseph Land, living-under the most insanitary conditions and without lime-juice-exclusively on "fresh-killed bears' meat and frozen blood", and yet none of them suffered from the disease.

The experiences of Dr. Nansen and Lieut. Johansen, who spent a winter on Frederick Jackson Island, under the most unhygienic conditions, and lived on fresh bear and walrus meat, without any lime-juice, would seem to sustain the view that the "vegetable theory" of Scurvy requires modification.

In a paper read before the Royal Society, on March 1st, 1900, yet another link is forged in the chain of evidence in favour of such a view. This paper dealing, as it does, with the observations of Mr. Jackson, and the experiments of Dr. Harley, in connection with this subject - describes the experiences of the crew of the "Windward", who contracted Scurvy, although taking lime-juice with tinned and salted meats, in contrast to those of the land party, who lived, almost exclusively, on fresh bears' meat, and yet escaped the disease.

And it is apparently the same in the case of the Samoyáds - according to Mr. Jackson -; who live, entirely, on fresh reindeer flesh, as contrasted

contrasted with those who, in common with the Russian traders, live upon salted fish: the former escape; the latter develop the disease. ⑦

Such facts as these, brought forward by competent observers, might well be regarded as giving all but absolute conclusiveness to the statement that "neither lime-juice nor fresh vegetables either prevent Scurvy or cure it", and that "it is not the absence of this which is the cause of the disease, but that Scurvy is a disease produced through eating tainted food". (Jackson and Harley) Recent investigations, however, have not confirmed this view.

Yet another ingenious theory has been advanced by Sir A. E. Wright, which maintains "that Scurvy is an acid-intoxication which eventuates in a defect of blood coagulability". ⑧

This argument is based upon the experimental fact that any excess of mineral acid taken into the system is normally neutralised by the alkaline salts of the food, and that, when the amount of alkali in the food is insufficient to combat the quantity of acid ingested, then the alkaline salts of the blood are called upon to meet the demand. In the carnivora and in man, this demand is met by the quantity of waste-product stored up in the body as Ammonia. But man has not the same faculty of resistance to ingested mineral acids that the carnivora possess, in virtue of the smaller amount of "acid food-stuffs", such as meat and cereals, which he consumes as

as compared with the latter. Hence, when through the deprivation of alkaline food-stuffs, (all green vegetables, fruits and fruit juices) there is too little alkali in the body to neutralise the acid ingested, in combination with meat and cereals; a condition of Acid-intoxication results which, it is alleged, reduces the system to that condition presented in a scorbutic patient.

According to this theory, all the haemorrhagic effusions, found in Scurvy, are ascribed to the reduced coagulability of the blood - a condition implying, also, an abstraction of its normal alkaline salts, and, consequently, diminished alkalinity. Obviously, such a condition is fraught with disaster to the animal organism, in as much as it deprives the blood of the power of eliminating carbon dioxide from the tissues and thus induces a state of profound marasmus. Therefore, in order to remedy such defects, one must aim, **FIRSTLY**, at supplying fixed alkali to the body, and, **SECONDLY**, at repairing the defect of blood-coagulability by the administration of suitable drugs - such as Calcium Chloride. It is now universally agreed, however, that this defect of blood-coagulability is not always present in Scurvy, although it may have been remarked in isolated cases; so that this explanation, like the others, must be regarded as inadequate. Some of these theories serve, at least, to illustrate how, in the domain of Science, the pendulum of thought is sometimes swung to the other extreme ; - a not uncommon feature in the history

history of human speculation - but they do not solve the problem of the etiology of Scurvy.

BACTERIOLOGY.

Some authorities maintain from observations made in Russia, that the disease is infective and dependent upon a specific micro-organism; but, so far, this view has received no support from Bacteriology.

Wierinski⁽⁹⁾ found that a sample of blood from the finger of a scorbutic patient was free from microbes, although examined both microscopically and by culture. Of 111 inoculations which he made, all, except 13, were sterile; but the latter were contaminations only. Four rabbits which were inoculated with the blood, remained healthy.

Albertoni⁽¹⁰⁾ found that Hyperchloric Acid was absent from the gastric juice, while there was no deficiency of the Chloride in the urine. Putrefactive processes in the urine, however, were much exaggerated - as estimated by Sulphites combined, and otherwise. The blood-serum was greenish-yellow; but there was no deficiency of Potassium salts in the blood itself.

Testi and B^eri⁽¹¹⁾ isolated a Diplococcus from the gum, which was found to be pathogenic to guinea-pigs.

Sophie and ^{M.} Noraczenskii⁽¹²⁾ found the Alkalinity of the blood reduced in Anaemia and Chlorosis.

Afanasi^eff⁽¹³⁾ isolated a coccus from an abscess, in a case of Scurvy, which neither stained by Gram's method nor liquified gelatine. It, however, made broth

broth viscous, produced gas, and was pathogenic to rabbits in large doses.

Jermakow⁽¹⁴⁾ found that Bacteriological examination was negative in 18 out of 26 cases; but positive in 5 out of 26. He, however, considers the latter result due to accidental contamination, and further hazards the opinion that Scurvy is, essentially, a chronic Toxaemia in which many other - usually innocent - organisms may develop and cause haemorrhages.

Lewine⁽¹⁵⁾ isolated a colon-like bacillus from from the liver and spleen of scorbutic patients during life, while they were in the ferbible stage. He found the bacillus in eleven out of twelve patients examined, and he considers it allied to Hueppe's Homo-septicus, and identical with fowl cholera, rabbit septicaemia and contagious swine-pneumonia. He was unable to find the bacillus described by Babes; but Babes found Lewine's Bacillus without attributing any importance to it.

Such a discovery as Lewine's, if corroborated, would place Scurvy among the Infectious diseases. As Scurvy, however, is now regarded as a "deficiency" disease, these observations have but a historical interest.

SIGNS AND SYMPTOMS.

These, in the main conformed to the descriptions found in text books: Petechial ecchymoses of the skin, haemorrhagic swellings in the neighbourhood

neighbourhood of joints - more especially the knee joints -, ulcers of the buccal cavity, and a brawny induration of the anterior aspect of the legs were the prevailing signs of the disease. Serious complications, such as Haemothorax and sero-sanguinolent effusion into the pericardial sac, were not uncommon, and, always, terminated fatally; but the spongy condition of the gums - usually regarded as an infallible sign of Scurvy - was, by no means, a constant characteristic in the cases under observation; so that some difficulty was, at times, experienced in arriving at a correct diagnosis.

It was absent even in the most serious cases admitted to Hospital. One example, in which an error in diagnosis was fraught with disaster to the patient, will suffice to show the difficulty occasionally experienced in identifying the disease :-

A Kaffir, employed in the Army Ordnance Department, consulted the Staff-surgeon in Bloemfontein for what appeared to be tooth-ache. A tooth was extracted, and the same native was, a few days later, admitted to Hospital to undergo treatment for general debility. At the site of the tooth - an upper molar - a spongy looking mass of tissue slowly formed and began to bleed. This sluggish haemorrhage continued for weeks, in spite of every effort made to stop it, while the spongy mass increased in size. The true nature of the case was at length realised; but a swelling appeared externally in the region of the Maxillary Sinus, which very soon occupied the whole side of the face, and, finally, closed and concealed the eye. When this

this swelling burst, it was found to have pushed its way, from within, through the external wall of the Maxillary Sinus, which was filled with spongy tissue mixed with a quantity of pus. The pus, was, also, found to have infiltrated the tissues of that side of the face - including even the eye-lids. The patient died shortly after, in a state of hyperpyrexia, - the temperature registering 107° Fahr. This example is instructive, inasmuch as its unfortunate termination, also, serves to emphasize the danger of surgical interference, of any kind, in the case of one suffering from Scurvy.

A striking feature in the disease was the, almost, universal complaint of PAIN in the CHEST. This pain was usually referred to the middle of the sternum; but the absence of cardiac mummings, and the failure to discover any morbid lesion, on post-mortem examination, sufficient to account for it, rendered its explanation difficult without entering into the uncertain region of speculation.

A certain degree of cardiac dilation and neurasthenia, resulting from malnutrition of the heart muscle, may be adduced as a not improbable cause of this symptom. The severe pains so frequently complained of, in the praecordial area, in cases of acute anaemia, have been, thus, explained by Burney Yeo,⁽¹⁶⁾ and there is no reason to doubt that the anaemia of Scurvy, which is, usually, of a severe type, may give rise to similar symptoms, despite the inability to appreciate any definite physical

physical lesion by means of the stethoscope.

The phenomenon of PYREXIA in Scurvy has apparently not been particularly emphasized in Medical literature. In the cases under discussion, however, an elevation of temperature was the rule rather than the exception. In the milder forms of the disease, the temperature for days ranged from 99 to 101 F.; in the more severe, it frequently rose to 103 F.; while some of those suffering from intercurrent affections died in a state of hyper-pyrexia.

There is a reason to believe - apart from the effects of the general vascular disturbance - the absorption of the products of extravasated blood was the efficient cause of continued pyrexia.

Haemorrhagic effusion into the tissues has given rise to fever in cases of simple fracture of the femur - the temperature in one case remaining high for ten days - as has been recorded by Volkman.⁽¹⁷⁾

The experience of surgeons, during the South African War, confirms this fact; for, in cases of bullet wounds of the chest, the temperature often remained high long after the wounds had healed. This proved to be due to unabsorbed blood-clot in the pleural cavity, and, as a consequence of this observation, it is now practically an axiom of military surgery that aseptic haemothorax may be an efficient cause of pyrexia. Further, positive evidence on this point has been accumulated in the recent European War.

BLOOD EXAMINATION.

The examination of the blood was carried out

out in association with Lieut. Col. Birt - R. A. M. C. Bacteriologist at the Military Hospital, Bloemfontein, in 1902-4.

The blood was usually obtained from the finger and tested by Wright's method, ⁽¹⁸⁾ in which standardised dilutions of Sulphuric acid are used: It was allowed to run into a blood capsule, and one or both ends of the capsule sealed up in the flame of a spirit lamp. It was, then, allowed to clot. When the clot had retracted and the blood serum had attained what Professor Wright terms "its definitive alkalinity" - i.e. - after a period varying from three to twenty-four hours - the ends of the capsule were broken off, and the clear serum obtained by inserting the end of a capillary pipette into the blood capsule. Equal quantities of serum and diluted normal sulphuric acid were then mixed together, and the resulting mixture was blown out, in a series of drops, upon strips of litmus paper. With a twenty-fold dilution of sulphuric acid we should find, in the mixture referred to, an excess of acid. "We should then proceed, "says Professor Wright", in a precisely similar manner, to tritrate, with each other, equal volumes of serum and a thirty-fold diluted normal acid. If we were dealing with normal blood, this mixture might or might not have a slightly acid re-action. If this mixture proved to be still acid, we should, of course, proceed to test equal volumes of serum and a forty-fold diluted normal acid. This mixture would in the case of normal blood, almost to a certainty, be alkaline. Supposing that it was

was alkaline, and that the reaction, of the mixture of equal volumes of serum and thirty-fold diluted acid, had proved to be acid, we should then proceed to mix, in a clean watch-glass, equal volumes of a thirty and a forty-fold diluted normal acid. We should tritrate our serum again with this thirty-five-fold diluted normal acid. If we found that this quantity of acid just sufficed to neutralise the acidity of our sample of serum, it is obvious that the alkalinity of our serum would be most simply expressed by the fraction $\frac{N}{35}$. For a serum which is exactly neutralised by an equal volume of a thirty-five-fold diluted normal acid would obviously correspond in alkalinity to a thirty-five-fold diluted normal solution of alkali. The maximum value found, by this method, for the alkalinity of the normal serum has been $\frac{N}{25}$. This result has been obtained only once. In the case of thirteen other normal persons the serum has been found to possess an alkalinity which has always varied between the values of $\frac{N}{30}$ and $\frac{N}{45}$. In an examination of the blood of 22 patients, the results were the following ;-

In 2 cases, the measure of alkalinity of the blood-serum was $\frac{N}{30}$, in 6 $\frac{N}{35}$, in 8 $\frac{N}{40}$, in 1 $\frac{N}{45}$, in 3 $\frac{N}{50}$, in 1 $\frac{N}{60}$, in 1 $\frac{N}{70}$.

In other words, the alkalinity falls below $\frac{N}{46}$ in 5 only out of 22 cases; it is average normal, $\frac{(N)}{(35)}$, in 6, still higher $\frac{(N)}{(30)}$ in 2, while the average for all the cases is equivalent to about $\frac{N}{42}$.

POST MORTEM EXAMINATIONS.

1. Kaffir aet. 20. Died 29/11/02. On inspection

inspection, Oedema of both thighs and spongy gums present. Body well nourished. THORAX. Lungs collapsed and bloodless - weight under 8 ounces. Right lung adherent at base. HEART dilated. Large ante-mortem clots distended all cavities, extending into Aorta and Pulmonary artery. - Muscle soft and pale. Valves normal. Serous haemorrhage in stomach and intestine. All other organs normal.

11. Kaffir. Died 4/11/02. On inspection, body emaciated. Oedema of both thighs. Diffuse infiltration of pus over left upper eye-lid. Brain-membranes oedematous. Excess of cerebro-spinal fluid, THORAX. Right lung adherent. Oedema of left lung. HEART distended with ante-mortem clot. Excess of fluid in Pericardium. All other organs normal. This is the patient who had tooth extracted before admission to Hospital.
111. Kaffir aet. 16. Died 9/11/03. On inspection, body ill nourished. THORAX Lungs normal, but pale. Pericardium contained 5 ounces clear fluid. HEART distended with large clots and muscle pale. All other organs normal.
- 1V. Kaffir. Died 11/11/02. On inspection, face bloated, most foetid smell from mouth. Sordes on teeth and gums blanched. Oedema of legs present. THORAX. Right pleural cavity contained six pints sero-sanguinolent fluid with clot. ~~Lung~~ collapsed and airless, with thickened parietal pleura. Left

Left lung normal. HEART enlarged and dilated with large ante-mortem and post-mortem clots extending into great vessels. Heart muscle pale. Slight excess of fluid in Pericardium. Spleen weighed 18 ounces - malarial. All other organs normal.

- V. Kaffir. Died 12/11/02. On inspection, Rigor Mortis marked. Temperature over 80 Fahr., although dead for 24 hours. Some ecchymoses beneath scalp and spinal muscles. THORAX. Left lung adherent. HEART weighed ten ounces. Anti-mortem thrombi in right side, Staining of Endocardium. Abdomen, liver congested, weighing 53 ounces. All other organs normal.
- VI. Kaffir aet. 30. Died 13/11/02. On inspection, body ill-nourished. Left thigh swollen; gums pallid and sordes on teeth. THORAX. Each pleural cavity contained four ounces of blood-stained fluid. Each lung weighed 35 ounces - both water-logged. Pericardium contained 3 ounces blood-stained serum. Abdomen, - Staining of upper end of large intestine. Petechiae on peritoneal surface of large and small intestine. Liver weighed 49 ounces, chocolate brown in colour. Left VASTI muscles - infiltrated with blood. PELVIS contained 3 ounces blood-stained fluid.
- VII. Kaffir aet. 50. Died 16/11/02. THORAX. Left lung oedematous, Pericardium contained 2 ounces

2 ounces of fluid. Heart dilated - contained $1\frac{1}{4}$ ounces ante-mortem clot - chiefly in right side. Mitral valves thickened. Weight of heart 13 ounces. Abdomen, Ecchymoses of stomach, Liver soft - weighing 50 ounces. Large extravasations of blood below fascia behind leg - infiltrating surface of muscles only.

- VIII. Kaffir aet. 30. Died 12/11/02. On inspection, left thigh and left leg swollen, Gums pale. THORAX. Left lung oedematous. Right Haemothorax about one pint blood, with clots in right pleural cavity. PERICARDIUM contained slight excess of clear fluid. Heart weighed $11\frac{1}{2}$ ounces - no clots. Blood effusions in both thighs and legs - extending in latter to the periosteum, which was loosened.
- IX. Kaffir aet. 30. Died 5/12/02. THORAX. Both lungs congested at base. Heart weighed $8\frac{1}{2}$ ounces. No clots. Cerebro-spinal fluid slightly blood-stained - $3\frac{1}{2}$ ounces present. Diffuse purulent infiltration of tissues of face.
- X. Hottentot aet. 40. Died 11/12/02. On inspection, body ill-nourished. THORAX. Emphysema of right lung. Left lung tied down to pericardium. Pleural cavity obliterated by old adhesions. Heart weighed $7\frac{1}{2}$ ounces. Muscle pale. Ante-mortem clots present. Atheromatous spots on Aorta. Other organs normal.
- XI. Kaffir aet 17. Died 15/12/02. On inspection, necrosis of lower jaw and side of mouth noted. Heart weighed 9 ounces - distended with ante-mortem

ante-mortem clots. Valves normal. Lower jaw laid bare by necrosis. Teeth abnormally displaced and gums ulcerated.

Xll. Kaffir aet 30. Few patchiae in right lung. Left lung adherent anteriorly. PERICARDIUM contained 4 ounces clear serum HEART with ante-mortem clots, weighed $10\frac{3}{4}$ ounces. Muscle pale. Valves healthy. Endarteritis of Aorta noted. Old Ecchymoses in arms, thighs and legs. Other organs normal.

Xlll. Kaffir aet 30. Died 25/2/03. THORAX. Right lung very oedematous - weighing $25\frac{1}{2}$ ounces. Left lung weighed $26\frac{1}{2}$ ounces - also oedematous. Right lung adherent in front. Right pleural cavity contained $10\frac{1}{2}$ ounces of clear serum. Left pleural cavity contained 6 pints of similar fluid. PERICARDIUM contained 2 ounces clear serum. HEART with ante-mortem clots weighed $13\frac{1}{2}$ ounces, $11\frac{3}{4}$ ounces without clots. Muscle pale. Liver weighed 48 ounces - fatty and friable. Ecchymoses in both coats of large Intestine. Peritoneal Ecchymoses present. There was one ounce of clear serum in abdominal cavity. Muscular haemorrhages were found in both legs and thighs.

With regard to the results of the post-mortem examination, one fact only need be emphasized, namely, the constant presence of ante-mortem thrombi in the heart and great blood-vessels. ⁽¹⁹⁾ These in some cases

cases were so large as to add considerably to the weight of the heart, while in others, they were found to have plugged the Aorta and pulmonary artery, at their points of origin. This phenomenon was somewhat disconcerting, considering what prevailing theories might have led one to expect.

The results of Lieut. Col. Birt's examination certainly point to a diminished alkalinity of the blood; but the diminution is by no means so serious as the gravity of the disease would lead one to expect.

Sophie and Moraczenski,⁽²⁰⁾ as has already been stated, found the alkalinity of the blood reduced in Anaemia and Chlorosis, and one might, legitimately, infer that the results obtained, from blood examination, in the above mentioned cases, were sufficiently explained by the Anaemia - often profound - which is always associated with Scurvy. But a reference to the condition of the blood, as found on post-mortem examination, again, adds to one's perplexity in view of the authoritative statements as to the diminution of blood coagulability in this disease. In pneumonia and other debilitating diseases, thrombi are frequently formed in the heart during the death agony, presumably owing to the waning power of the ventricular systole, and it is more than probable that the thrombi found in the heart after death from Scurvy, ^{were} ~~are~~ due to similar causes. It would, therefore, appear that in the view, that the blood coagulates normally,⁽²¹⁾ in this disease, is to be found the truth of the whole matter.

TREATMENT.

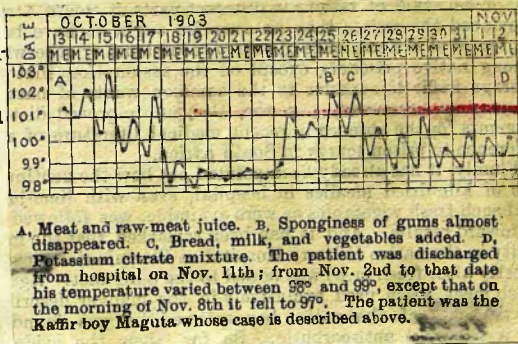
The usual hospital diet for a native consisted of half a pound of mealie meal three times a day. To this was added, for each scorbutic patient, a daily

daily allowance of four ounces of lime-juice, and two ounces of sugar. Three months' experience of such a diet proved unsatisfactory - in fact, disastrous. Within that period nine kaffirs had died, and the survivors had made very little progress towards recovery. Calcium chloride, in doses of ten grains thrice daily was given, but, in view of the increasing mortality, its use was soon, abandoned. At this stage it was thought advisable to reconsider the dietary. as the utmost freedom was allowed in the choice of fresh food and vegetables. Half a pound of fresh meat was added to the daily dietary of each patient; it was, partly, broiled, and, partly, utilised as raw-meat juice. In addition to this, each individual received ten ounces of fresh vegetables, four ounces of jam, and four ounces of fresh fruit; while a mixture, consisting of citrate of potassium and infusion of calumba, was given thrice daily. The good effects of this treatment soon became evident. In about ten days, patients, who had been too weak to stand, when admitted to hospital, began to walk, haemorrhagic swellings gradually disappeared, and the fever abated. Further, of the 13 deaths referred to, two only fall within this period; but they occurred at so early a stage of it that it may reasonably be inferred that the change in treatment was too late to benefit them.

In consequence of such good results it was decided to test the value of fresh meat alone as a remedy in Scurvy. Accordingly, a kaffir boy (Maguta) who presented the signs and symptoms of the disease in a marked degree, was selected for this special diet. His gums were spongy, the last lower molar

molar teeth were surrounded by tags of bleeding tissue, and the hard palate was covered with small petechiae. He could hardly stand when admitted to hospital. On the fourth day after his admission, although his temperature registered 101 F., he was put on the diet already described.

To this two
milk were ad
By the sixth
had fallen
this stage
fresh meat
two pounds



pints of sterilised
ded as a "placebo".
day the temperature
below normal and at
the quantity of
was increased to
per diem. The

temperature again rose slightly and remained high for a few days; but when the mouth and gums were examined, on the twelfth day, it was found that the tags of bleeding tissue had disappeared, and that nothing remained in the mouth indicative of Scurvy, beyond a few petechiae on the hard palate. The temperature, still, remained elevated and the legs were slightly swollen and tender, but the patient could now stand with ease. Fresh vegetables were added to the meat diet and in two weeks' time the patient, having made a good recovery, was discharged from hospital. (22)

It may be added that the results obtained in many cases by substituting a liberal supply of fresh milk, bread and vegetables for meat were also fairly good. It was still felt, however, that recovery in many cases was slow enough to shake one's faith, at times, even in the best remedies at one's disposal.

SUPPOSED CAUSES.

If the exact causes of this outbreak of Scurvy

Scurvy cannot be unequivocally determined, something of importance at least may be gathered from a consideration of the circumstances attending and preceding its occurrence from facts observed by others and from the results of treatment. Most of the Kaffirs who gravitated to Bloemfontein after the war had followed the fortunes of the British army for nearly three years previously, and during that time they had been served with the same rations as the British soldier - namely, preserved meat and vegetables. The food was good, and, consequently, in spite of many hardships, the kaffirs who were on active service, remained healthy, while Scurvy was not unknown among those located in refugee camps. After peace was declared, however, the conditions of service with the Government were reversed; the natives providing all their own food, except the kiln-dried mealie which was issued as the Government ration.

Those who know the kaffir and his haphazard habits, in regard to securing food, will not, readily, infer that, in these circumstances good meat was more than a precarious element in his daily diet. In any case these were the conditions, so far as ascertainable, under which the disease occurred in Bloemfontein, and it may be presumed that those cases found among natives not employed by the Government were in a measure contributed to by the conditions, necessarily, arising out of a state of war, which cut them adrift from farms on which they were regularly employed and fed, and where the fresh South African grown mealie formed a more or less certain constituent of their daily fare. The use

use of imported mealie has at different times been adduced in explanation of outbreaks of Scurvy in the South African mines, and an outbreak in the Southern Bechuanaland Protectorate in 1903 followed upon the substitution of the American for the African grown mealie.

It was proved from observations made by Dr. Donald MacRae, that the outbreak of Scurvy in the prison of Gaberones, Bechuanaland, was contributed to by the exclusion of meat, except in the case of Europeans, from the prison dietary. Natives doing hard labour were fed on mealie meal thrice daily, but European prisoners were allowed one pound of fresh meat per diem in addition. Scurvy of a most intractable kind broke out among the natives, while the Europeans escaped the disease. The inclusion of fresh meat in the native dietary, however, has completely banished Scurvy from the Gaberones prison.

A casual examination and comparison made many years ago of the prison scale of rations in different parts of South Africa convinced the writer that no surprise ought to have been expressed at the existence of Scurvy, occasional or otherwise, among native prisoners, except on the assumption that the average kaffir is superior to the common wants of nature. An improved dietary accounts for the absence in recent medical literature of any reference to prison Scurvy in South Africa.

Finally, it has already been pointed out how the continued use of kiln-dried mealies in hospital, even with lime-juice and such fresh vegetables as were available, was followed by untoward results. And

And it has been remarked that the mortality in the native Military Hospital at Bloemfontein nearly ceased shortly after fresh meat was added to the daily diet. Again fresh meat, when used exclusively in the manner described in the case of the native boy referred to, was found to be a good antiscorbutic. So far, then, the evidence connecting the incidence of the disease with a deficiency of fresh vegetables is more or less direct, while that associating it with want of meat is less direct than inferential. The writer's views on this subject were thus expressed in the "Lancet" in 1908 :-

GENERAL REMARKS.

" Although the explanations of Scurvy
 " hitherto given - from the etiological side -
 " can at best be received only as graduated
 " certainties, liable at any time to correction
 " or revision, still the arguments advanced at
 " different times in support of the prophylactic
 " and curative remedies employed in the disease
 " are based upon the practical experience of
 " competent observers. When in the domain of
 " speculative or scientific thought, eminent
 " men are divided in opinion they, usually,
 " divide the truth between them. Whatever
 " differences of opinion may exist in regard to
 " the etiology of Scurvy, or the methods of
 " treating the disease, it seems that one point
 " has not been sufficiently emphasised on which
 " all might well have agreed - namely, that in
 " a disease which reduces the body to a condition
 " of extreme debility, the remedy which is best
 " calculated to yield the maximum of energy in
 " the minimum of time is that which ought, in
 " the first place, to be applied. Specifics
 " apart from this are valueless. The juice of
 " fresh raw meat, owing to its stimulating and
 " nutritive properties, is well suited to such
 " a condition. And the same may be said of fresh
 " milk, the albuminoid constituents of which
 " supply the place of the rich animal food mentioned.
 " Both are antiscorbutics, both supply energy, and
 " both entail the minimum of strain upon the
 " assimilative functions of the body."
 " It is a fact of clinical experience,
 " supported by the authority of generations

" generations of observers, that the addition
 " of fresh vegetables and lime-juice to an
 " ordinary "general diet" cures the average
 " case of Scurvy. But since it has been recently
 " observed that a certain constituent of what is
 " called a "general diet" is itself a good anti-
 " scorbutic, doubt has arisen as to whether the
 " virtues ascribed to the time-honoured specifics -
 " fresh vegetables and lime-juice - have not often
 " been largely reinforced by that component of the
 " "general diet" to which specific qualities were
 " not attributed in the past. It seems beyond
 " doubt, however, that the elements necessary to
 " maintain the equilibrium of bodily health belong
 " to both fresh vegetables and animal food."

" The question as to the relative value
 " of meat and vegetables in the treatment of
 " Scurvy is an old one, however, for this was a
 " moot point among naval surgeons as early as 1797.⁽²³⁾
 " The eminent physician, Sir Thomas Watson, used
 " roast beef in the treatment of the disease and
 " has spoken highly of its efficacy.⁽²⁴⁾ And it may
 " be gathered from the records of the early
 " navigators that the Island of Juan Fernandez
 " proved a paradise for their stricken crews, not
 " merely on account of its richness in fresh
 " fruits and vegetables, but also because "it
 " abounded in herds of wild goats", the flesh of
 " which, as Dampier tells us, formed part of the
 " dietary of his scorbutic sailors."

It will be seen from this extract that the
 writer felt that the older physicians were right, and
 that there must be some defect in our knowledge as to
 how they had achieved such brilliant results in their
 treatment of the disease. The work of Mrs. Alice
 Henderson Smith and others - presently to be more
 specially referred to - proves that his faith was
 well justified.

The observations recorded in this paper were
 made by the writer in 1903. Since that time several
 important contributions have been made to the
 literature of Scurvy by Froelich and Holst and others.
 In a paper read before the British Medical Association
 at Sheffield in 1908, Professor Axel Holst of
 Christiania announced the important fact that he and
 Dr. Froelich had been able to induce the disease

disease experimentally in animals, by feeding them for about three weeks on dry cereals and water. ⁽²⁵⁾ This announcement is supported by experimental evidence of the most unequivocal kind; and the value of Froelich and Holst's conclusions are further enhanced by the established fact that the addition of anti-scorbutic food-stuffs to the diet described, favourably influenced the cause of the disease. The result of these investigations may be briefly summarised as follows :-

- I. If a guinea-pig be fed on fresh boiled potatoes, it will die in about two months without showing signs of Scurvy.
- II. If it be fed on compressed and dried potatoes, it will die in a few weeks, with the signs and symptoms of Scurvy.
- III. If a guinea-pig fed on dry cereals and water be given a little raw fresh carrot, it will live for months without developing Scurvy; but, if dry carrot be given instead, the animal will soon die of Scurvy.
- IV. A guinea-pig fed on oats and water, or bread and water, will die of Scurvy in a few weeks; but, if to this diet an ounce of freshly prepared cabbage -juice be added, the guinea-pig will not develop Scurvy. If, however, the cabbage-juice be kept for a month its efficacy is lost.
- V. A guinea-pig fed on barley, soaked in water, will soon die of Scurvy; but if the soaked barley be allowed to sprout before it is given as food, Scurvy will not develop.

In the same paper, Professor Holst incidentally disposes of Sir A. E. Wright's auto-intoxication theory of the disease on the following grounds :-

- I. Potatoes boiled in Hydrochloric Acid, before being dried, do not produce Scurvy more readily than those prepared in an incubator at blood-heat.
- II. In the experiment with dried carrots, a guinea-pig will soon die of Scurvy, even if the carrots be soaked in a solution of

- of bicarbonate of soda, or some of that salt be added daily to the animal's drinking water.
- III. The anti-scorbutic value of cabbage-juice, when lost by keeping, is not restored by the addition to it of bicarbonate of Soda.
- IV. Soaked barley is found to contain the same amount of acids and salts before and after sprouting.
- V. Cereal-fed guinea-pigs die of Scurvy, notwithstanding the liberal addition of Calcium Carbonate and Sodium Citrate to their drinking water.

Professor Holst further stated that he had examined the blood of several of the scorbutic guinea-pigs, by Sir A. E. Wright's method, and found the alkalinity diminished in some cases, while in others it was normal .

Dr. Robert Hutchison, in continuing the discussion, drew attention chiefly to the fact that the lowered alkalinity of the blood in Scurvy was of little value in support of the acid-intoxication theory, inasmuch as scorbutic patients were always anaemic, and the alkalinity of the blood in anaemia was usually reduced.

The Pyrexia, which was a constant feature in many of the cases of Scurvy met with during the Anglo-Boer War, was confirmed later by Dr. MacVicar of Lovedale Hospital, Cape Province, ^(25^a) and the explanation of it already offered in this paper, finds support in the work of Professor Dieulafoy of Paris, ^(25^b) who says :-

" We know that fever may last for some time
 " in cases of Haemothorax, quite apart from
 " infection, and we now admit that absorption
 " of the red corpuscles gives rise to fever."

As already stated, this view has been further verified in the great European War.

The recent work of Chick, Hume, Skelton and

(26)
and Smith confirms the findings of Froelich and Holst in 1912. They found that :-

1. The expressed juices of acid fruits are more stable than those of fresh vegetables; that vitamins are present to a greater extent in fresh fruit and vegetables, less in root vegetables and tubers; still less in fresh meat and milk, and not yet detected in yeasts, fats, cereals and pulses.
2. Fresh lime-juice, in daily doses of 10.c.c., was found to confer definite protection from Scurvy. Fresh lemon-juice, in doses of 1.5.c.c. secured almost complete immunity over a period of from 4 to 7 months; with lime-juice, health was maintained for 3 months only. The value of fresh lemon-juice was found to be four times that of lime-juice. Dried milk was found to confer insufficient protection, and raw unboiled milk very little. The order of the Cruciferae proved the most effective in anti-scorbutic properties - e.g. - the Swede, cabbage, Scurvy grass (*Cochlearia officinalis*) and cresses. In descending order come the Umbelliferae (carrots), Solanaceae (potatoes) and Chenopodiaceae (beet-root).⁽²⁷⁾ Further, Mrs. Alice Henderson Smith has made the interesting and important discovery that lime-juice as now prepared is not the same as that which by 1810, had banished Scurvy from the Navy and Mercantile Marine. The lime-juice now supplied is made from *Citrus Medica*, var. *Acida* - the sour lime grown in the West Indies. That used in the Navy and Mercantile Marine, up to about 1866, was made from Mediterranean lemons-*Citrus medica limonum* - which also included the sweet lime-*Citrus medica limetta*. In 1866, however, the Admiralty transferred its contract to the West Indies, and issued the juice of limes instead of lemons, which was supposed to be better, until Arctic exploration and the conditions of War - even down to the present time - proved its deficiency.

In the Sir G. Nares Expedition of 1875, the West Indian lime-juice failed to prevent Scurvy, the disease becoming serious even before the end of the first year. In the Expedition of 1850, which was supplied with the old lemon-juice, the crew of the "Investigator" though the ration had to be halved before her return, lost only three men from Scurvy in 3½ years. The same number of deaths had occurred

occurred in the Sir G. Nares Expedition in one year. The efficacy of lemon-juice in the voyage of the "Investigator" is confirmed by the experience of other contemporary ships, while the failure of lime-juice in the Nares Expedition is repeated in the Anglo-Boer War, Capt. Scott's Arctic Expeditions, and in France, Mesopotamia and Servia during the late War, - all expeditions in which lime-juice was relied upon as an anti-scorbutic.

Historical evidence thus, clearly, confirms biological research, and, what is still more important, the results of these investigations can be readily applied to the prevention of disease. The accessory food factors (vitamines), the benign influence of which is necessary to health, are proved to be common to many foods, but are especially present in fresh lemons, oranges, green vegetables and Swedes; and, to a lesser degree in meat, milk, potatoes and other roots and tubers. These vitamins are very susceptible to alkalis, so that soda should not be used in cooking them. ⁽²⁹⁾ They are completely destroyed by heat. The anti-beri-beri vitamins exist, chiefly, in the seeds of plants, such as cereals and edible pulses, and in the eggs of animals, where it nourishes the embryo. Decorticated rice causes beri-beri, and, as the addition of the rice polishings and their extracts prevents or cures the disease, it is held that the anti-beri-beri vitamin is situated in the aleurone layer of the husked grain - below the pericarp. It has also been proved that the largest amount of vitamin is situated in the embryo, which is removed in the process of

of milling. It is very resistant to drying, but is destroyed by a T of 120 C under pressure. White wheaten bread is thus deficient in vitamine and its exclusive use will cause beri-beri. The embryo and bran of wheat, as in whole meal bread and standard flour, should, therefore, be supplied to troops on active service, who, rely mainly on tinned rations in which the vitamins are lost by sterilisation at high temperatures. Germinating pulses, in the absence of fresh fruit and green vegetables, were used successfully by Dr. Wiltshire in Servia as antiscorbutics. (30) Their great value has^{d.} previously been proved experimentally by Chick, Hume and Skelton. Thus, though dried seeds contain no vitamine, these can be re-created by moisture, when germination results. They should be eaten soon after germination, as it is important that they should not become dry.

In the light of all this recent addition to our knowledge - for the experiments of Dr. Harriette Chick and her colleagues at the Lister Institute may be regarded as generally conclusive - the existence of Scurvy on a serious scale need scarcely be looked for in the future. Even should it occur under exceptional circumstances, it can now be faced with a sure confidence in the efficacy of the remedies at our disposal. The writer is still of opinion that fresh meat must always be an important factor in any well-balanced dietary for scorbutic patients. Clinical experience has convinced him of its value; for it banished Scurvy from the prisons of South Africa, when recommended by him in the Lancet in 1908. An abstract

abstract of this article was later published in the S. A. Medical Record in 1912.

The epidemic of Scurvy, which broke out among the men of the S. A. Labour Corps in France was found, by Capt. Hamilton-Dyke,⁽³¹⁾ to be largely due to over-cooking of the meat ration. The disease disappeared as soon as the meat was cooked for 40 minutes, instead of 2 hours. The only qualification that need be made in this connection, is that the meat ration should be a very liberal one. It was found in Mesopotamia by Col. Wilcox,⁽³²⁾ that British troops were practically exempt from Scurvy, owing to a liberal meat ration. Indian troops, however, who, from racial prejudices, could not use meat suffered seriously from Scurvy, - 11,000 cases occurring among them from July to December, 1916.

Capt. Bassett-Smith⁽³³⁾ has recently introduced the use of Tabloids of preserved lemon-juice in the Royal Navy, - an innovation, which appears to be the latest important contribution to the history of the subject of this paper.

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