ASCORBIC ACID EXCRETION AMONGST NAVAL PERSONNEL IN SMALL SHIPS

With Special reference to

INFECTIVE GINGIVITIS

by

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INTRODUCTION.

I should like to express my thanks to Dr. C. P. Stewart for his encouragement, helpful criticism and for the loan of apparatus, throughout the work for this thesis. Criticism by Dr. James Innes was also of great value.

To Surgeon Commander C.C. Ungley, R.N.V.R., I am much indebted for help in unearthing some of the relevant literature.

For permission to perform the work amongst service personnel, for the provision of the necessary beds and for criticism, from a service point of view, I am most grateful to my P.M.O., Surgeon Commander W. F. Beattie, R.N.

Lieut. Robert Butler, R.N.V.R. has very kindly executed the illustrations, based on plates from Meads' "Diseases of the Mouth", (1940)

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PART I — Estimation of Vitamin C excretion amongst naval personnel in small ships.

Tabulated Results:

Series 1 — Ascorbic Acid excretion rates of 100 healthy ratings on full duty.

Series 2 — Ascorbic Acid excretion saturation tests on 5 ratings in the Sick Bay with non-metabolic disorders.

Series 3 — Ascorbic Acid excretion saturation tests on 10 healthy ratings on full duty.

PART II — Ascorbic Acid saturation and its relationship to Infective Gingivitis - a review of 36 cases.

Tabulated Results:

Series 4 — Ascorbic Acid excretion rates of 36 cases of Gingivitis.

Series 5 — Case histories of 14 Ratings all suffering from Vincent's Stomatitis and treated with 700 mgm. Ascorbic Acid daily.

Series 6 — Comparative analysis of Ascorbic Acid saturation of 36 cases of Gingivitis and of 100 healthy ratings.
(i.e. correlation of Series 1 - 5).

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ESTIMATION OF VITAMIN C EXCRETION AMONGST NAVAL PERSONNEL IN SMALL SHIPS.

The following investigation was carried out at one of H.M. Trawler bases during October and November, 1941 at the instigation and under the supervision of Dr. C.P. Stewart of the Clinical Laboratory, Edinburgh Royal Infirmary. All the results have been submitted to him and are to form part of a longer and more comprehensive investigation involving ratings from other ports. The results are also to be compared with a similar series of figures obtained at the end of last winter, the object being to determine the effect of summer feeding in small ships upon the fairly marked degree of deficiency which was noted at the end of last winter, the cases at that time being classified as sub-clinical hypovitaminosis C and were very general in distribution amongst naval personnel. A report on the situation was submitted to the Medical Director General of the Royal Navy in the Senior Medical Officer's Journal, December, 1941 and incorporated some of the subject matter of the first part of this thesis. Further additional work was performed throughout the following year and has been included in the present narrative. The estimations in the Series 1, 2 and 3 were all performed during the winter and spring of '41 and '42, while those of Series 4, 5 and 6 were done during the spring and summer of '42, when more beds were available for experimental work, although cases of infective gingivitis were not so numerous then as earlier in the year.

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In the original investigation three separate series of cases were considered. In the first of 100 Ratings, all healthy and on full duty, a single saturation test, as described below, was performed, the ratings being taken as a cross section of the naval community at this base and contained individuals from the shore base, the dockyard, the Sick Bay and from the Trawlers, all picked more or less at random. In the second series of cases, 5 ratings from Trawlers, all inmates of the Sick Bay for the sake of convenience, were given a daily dose of 700 mgm. Ascorbic Acid by mouth, and a full saturation test performed daily with the object of determining how long it would take to saturate them, thus obtaining an estimate of the degree of unsaturation present. The third series of 10 ratings, all healthy and on full duty and again picked at random, were given 700 mgm. Ascorbic Acid by mouth daily and estimations performed to obtain the degree of unsaturation until they reached saturation point. In this series however, owing to the difficulty of obtaining three attendancies daily and the vesical co-operation of the patient, a compromise was affected by estimating the overnight specimen of urine only, until the fourth day when a full saturation estimation was performed. The validity of this method and the accuracy of the results will be discussed below.

Throughout the entire investigation all the titrations were performed by myself, thus ensuring both a uniform "end point" and making the results comparable amongst themselves.

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The "end point" is open to individual differences of interpretation since the reduced indo-phenol does not become colourless in urine, as it does in an aqueous solution,but assumes the original colour of the urine. To ensure uniformity the titrated test tube was always compared with a similar tube of the original urine.

The sum total of the three series of cases can thus be regarded as an estimation of the Ascorbic Acid excretion in 100 ratings, followed by attempts at saturation with a high daily dosage of Ascorbic Acid, in a small series of cases, to obtain an estimate of the degree of unsaturation present, by seeing how long it took for these ratings to become saturated.

In addition the capillary resistance, which formerly was considered to be an index of vitamin C subnutrition, was measured in each case. The method employed by Göthlin in Sweden (1931 Skand.Arch.Phys. 61.225.) was only roughly followed. A short clinical history and dietetic history were also taken in each case.

The method employed was that first introduced by Tillmans in 1932 (1932. Zeit.f.Untersuch des Lebensm.LXII:241) in which he describes the titration of urine against the "Redox" dye 2.6 dichlorphenol-indophenol. This method was employed by Harris and Ray in 1935 (Lancet.1935.1.71) in investigating the diagnosis of Vitamin C subnutrition by analysis of urinary excretion in infants and adults suffering from scurvy. They summarised their article as follows "Infants suffering from manifest scurvy, or with a history of Vitamin C/

Vitamin C underfeeding excrete less Vitamin C in their urine (measured chemically) than do well nourished infants of the same age tested under the same conditions (re controlled diets, low in Vitamin C), the difference can be made more strikingly manifest by the administration of a large dose of Vitamin C. A marked peak results in the curve of the urinary excretion for normal infants, but not for the unsaturated scorbutic infant or semi-scorbutic infants. After cure the scorbutic infant behaves like a normal infant both in its output of Vitamin C on ordinary diets (or controlled Vitamin C free diets) and in his response after a test dose."

Further observations on adults are also reported showing that a low urinary output and a low response to test dose, go parallel with a history of Vitamin C, underfeeding and with a state of Vitamin C subnutrition as indicated by a lowered capillary resistance (vide infra). In 1940 Harris (Lancet 1940.2.259) supplemented this work by an investigation into the assessment of the level of nutrition tests for Vitamin C in groups of poorly fed and well fed school children, and produced confirmatory results. In this work he refers to the simplified technique now employed and states, on the basis of the previous investigation (Harris and Abbasey 1937) (Lancet. 1937. 2.1429) any person not reaching the saturation level on the second day of the test dosing is regarded as being below standard. Past observation has indicated that the minimum of Vitamin C needed to protect against the slightest signs of scurvy is about 25 mgms. per day for the child and 50 mgms. per day /

day for the adult. The League of Nations marginal requirement is 30 mgm. per day.

A search of the literature shows that various opinions have been held as to this minimum value. Harris summarises them in a footnote of his latest article (Lancet 1942.1.644) pointing out that relatively more Vitamin C appears to be needed by the young organism than the adult. Sybil Smith (1938 J. Amer. Med. Ass. 111. 1753) after a comprehensive review estimated the daily requirements as approximately 50-60 mgm. for adults, 40 mgm. for children and 20 mgm. for infants. "These we regard as the middle, or barely adequate, consumption levels with but little margin of safety". The minimal requirement needed for certain protection against scurvy appears to be in the neighbourhood of 15-20 mgm. per day for an adult. Thus 12 cases of scurvy were seen in 950 native mine labourers receiving 12-25 mgm. daily by Fox and his colleagues. (1940 B.M.J. II. 143). Esquimaux need about 15 mgm. to prevent scurvy and about 25 mgm. seems necessary to restore capillary fragility to normal according to Göthlin and his colleagues (1937 Acta. Med. Scand. 92. 1.)

The League of Nations (marginal) standard is 30 mgm. per day for an adult as mentioned above. The United States National Research Council (1941 J. Amer. Med. Assoc. 116.2601) considers the desirable intake for an adult to be 75 mgm. per day and similar optimal requirements (75-100 mgm) are given by other authorities. A German Official advised 30-50 mgm. per day (Scheunert, A. 1940 Dtsch. Med. Wschr. 66. 365).

Harris /

Harris himself considers that an intake not greatly in excess of the League of Nations marginal standard will suffice to keep the organism at such a level that saturation, as already defined, is reached on the second day of test dosing. With the higher intakes (75-100 mgm. per day) saturation will be completed on the first day of dosing (i.e. the organism is in a state of pre-existing saturation).

In the above article (Harris 1940) a concise account of the technique of titration is given, and this has been closely adhered to in the present series of cases. In the original technique (1935) the estimation was performed on 24 hour specimens of urine, and the daily Vitamin C output at different ages given. The figures are 1-2 mgms. per day for a young child, and 15-30 mgms. per day (0.2 - 0.3 mgms.%) for an adult. In 1940 however, Harris (11) modified the technique by estimating the overnight specimen of urine, giving the test dose of 700 mgms. Ascorbic Acid by mouth, emptying the bladder three hours later, and then estimating the six hour specimen which shows the maximum excretion; a rise of 5 mgms. between the morning and the six hour specimen being regarded as saturation. More recently Payne and Topley 1941 (Lancet. 1941. 2. 596) carried out a similar investigation on convalescent children in Great Ormond Street Hospital. In this they attempted to find the minimum daily dose required to maintain saturation in the saturated case and thus verify Harris's figure of 25 mgms. per day. Unfortunately this work is still incomplete owing chiefly

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to losing sight of their cases, but a further paper is underway. It is on the basis of all this previous work that the present investigation was planned.

At one time there was considerable doubt as to whether Ascorbic Acid was the constituent of urine estimated by this method and also whether Ascorbic Acid was contained in urine at all. Some observers, particularly Van de Walle in 1922 (Biochem.J. 1922.713) were unable to detect Vitamin C in human urine by biological test. Harris however, countered this by pointing out that not enough Vitamin C was fed to the Guinea Pigs nor was it fed soon enough after passing.

In 1937 however, Drumm, Scarborough and Stewart (Biochem.J.1937.1.1874) isolated the product from urine, and summarised their paper with "from 12 litres of urine, 20 mgms. of the pure 2.4 dinitrophenyl-hydrazine derivative of dehydrascorbic acid were isolated after repeated absorption in aluminium oxide, and crystalisation from acetic acid and from acetone or acetone-alcohol." This was followed shortly by a paper, also in 1937, by Scarborough and Stewart (Biochem.J. 1937. 31. 2232) pointing out that certain substances interfering with the indophenol method of titration, chiefly thiosulphate, could be removed from the urine by mercuric acetate, but that for practical purposes these substances caused no appreciable interference if the titration was done quickly, taking in fact not more than two minutes.

The use of "hexoxidase" from cauliflower shows that reducing substances other than Ascorbic Acid are still present in urine following treatment with mercuric acetate.

Prolonged /

Prolonged treatment with hydrogen sulphide increases the indophenol reducing power of urine and it is confirmed that acid hydrolysis has a similar effect. Hydrolysis followed by reduction produces the maximum increase. Enzyme experiments (using cauliflower enzyme) show that both these increases are due in part to production of extra Ascorbic Acid (if the enzyme is specific), which is probably present in the urine partly in the "reduced" form, partly as a dehydro-ascorbic acid and partly as non-reducing hydrolisable derivatives of these substances. Associated with Ascorbic Acid is another indophenol reducing substance closely resembling it in properties and also existing in non-reducing "oxidised" and "combined" forms.

Thus if all these precautions with regard to the speed are taken, the titration is performed quickly,carefully, and accurately, and a sufficient number of cases are considered, the results obtained are a measure of the level of Vitamin C nutrition in any community.

An interesting critique of the method of test, on much the same lines as above is to be found in an article by Harris (Lancet 1942.i.644) where objections raised at different times are enquired into in detail and the conclusion is reached that the method is reliable.

Whether or not a state of "saturation" is indicative of an optimum condition is open to question. It is asserted by some that many people are found to be "unsaturated" by the excretion test and yet are in perfectly good health. Thus

Fox /

Fox and his colleagues (B.M.J. 1930.II.143) point out that among their mine workers, all of whom were living on a low Vitamin C diet, the incidence of the hours of work lost was the same as amongst those given a supplementary daily ration of orange juice.

Zilva (1942 Biochem.J.35.1240) takes the view that the body reserves of Vitamin C are considerable and even when the normal intake is depleted it is some considerable time before frank signs of the lack begin to show themselves. Harris, on the other hand, (1942. Lancet.1.644) maintains that the absence of clinical signs of scurvy does not imply a sufficiency of Vitamin C. The actual onset of scurvy is sudden and it is dangerous, in his view, to disregard evidence of its approach. Amongst our own cases it has been remarkable and sometimes dramatic, the change that is wrought in those with a marked degree of unsaturation by massive daily dosage with Vitamin C. Prior to treatment these cases were all pale, easily tired and showed lack of interest. Following treatment there was a marked change in complexion to a healthy ruddiness, there was a sparkle in the eye, and a greater zest in living. Nearly all these cases commented themselves on how unusually fit they felt after reaching saturation point. Since these cases were all inmates of the Sick Bay other factors such as leisure, regular and long hours of sleep, good food and fresh air, must be borne in mind in producing this result. The finding does however, point to these ratings being in a sub-optimal state prior to treatment, although apart from the Gingivitis /

Gingivitis for which they were admitted, they were superficially "healthy" and fit to do their day's work. Any discussion on optimum health involves the reflection that the vast majority of so called healthy individuals, although fit for their normal and accustomed activities, are not living at their optimum, in the true sense of the word, and are often incapable of performing any unaccustomed or prolonged exertion. Similarly it may be said of Vitamin C nutrition that the majority of the populace are demonstrably deficient (as is shown in our own survey) and yet superficially healthy, but are not living at their optimum. Certainly the assessment of the Vitamin C nutrition, by the excretion method, is of value in determining how near to the scorbutic level any one individual has descended, irrespective of the significance of the minor degrees of unsaturation.

With this preliminary discussion of the method of investigation, its accuracy, and the previous work done along these lines, we shall now attempt to summarise our own investigations. The individual readings are all appended in tabular form in Series 1, 2 and 3.

In Series 1, of 100 healthy ratings, but including a few with minor ailments, a full saturation test was performed in an attempt to assess the degree of hypovitaminosis C present in the community. In this assessment the following standards were adhered to. Ratings showing a difference of less than 2 mgm% between the two estimations were classed as "severely unsaturated". Those with a difference of 2 mgm% - 5 mgm% were classed /

classed as "mildly deficient", while those with a difference of 5 mgm% or over were counted as "saturated" : due allowance being made in each case for the dilution and quantity of urine passed.

The justification of this method of assessment is to be found in Series 2, 3 and 5 where ratings were exposed to daily dosage of ascorbic acid (700 mgm/day). Ratings showing a difference of less than 2 mgm% between the two specimens, took on an average 5-8 days to saturate. Those showing a difference of 2-5 mgm% between the two specimens took on an average 3-4 days to saturate, while those showing a difference of 5 mgm% or over between the two specimens were saturated in 1-2 days.

On this basis an analysis of Series 1 is as follows:-

ANALYSIS OF SERIES 1.

100 Ratings submitted to a full saturation test.

(A) Total Numbers.

Saturated	15%	
Mildly unsaturated	60%)	85%
More severely unsaturated	25%)	
	100%	
Unsaturated and showing clinical signs.	27%	

(B) Trawlermen.

Saturated	6 = 15%	
Mildly unsaturated	27 = 67.5%)	85%
More severely unsaturated.	7 = 17.5%)	
	40 = 100.0%	
Unsaturated and showing clinical signs.	18 = 45%	

(C) Cases from the Shore Base and Dockyard.

Saturated	3	= 5.0%	
Mildly unsaturated	29	= 48.3%)	95.0%
More severely unsaturated	28	= 46.7%)	
	60	= 100.0%	
Unsaturated and showing clinical signs.	12	= 20%	

(D) Cases resident in Sick Bay.

Saturated	7	= 26.9%
Mildly unsaturated	16	= 61.5%
More severely unsaturated	3	= 11.5%
	26	= 99.9%

Of the total number of cases it will be seen that only 15% were saturated, 60% were mildly unsaturated, while 25% showed a more severe degree of unsaturation, while of the unsaturated 27% only showed clinical signs, chiefly Vincent's disease of the gums (but vide infra) sometimes accompanied by pyorrhoea, and usually by lassitude. Only 4 cases showed signs of a more general subnutritional state in addition to Gingivitis, in multiple boils, tendency to bruising, conjunctivitis etc., and these were all severely unsaturated.

Amongst the saturated, in all 4 groups it is worthy of note that none showed any of the clinical signs of Vitamin C lack; a finding which would support the validity of the association of these signs and a state of unsaturation, particularly so when these signs occurred exclusively in those demonstrably lacking the vitamin.

Conversely it is to be observed that those showing any clinical /

clinical signs at all, whether in the gums, or in the patients' general health (i.e. multiple boils, lassitude, chronic catarrh and slow healing of wounds and ulcers) were all found to be deficient in Vitamin C.

When these cases are further subdivided according to their occupation and mode of living, several interesting facts emerge. Of the already saturated it is seen that a higher proportion is to be found amongst the trawlermen (15% compared with 5%) than amongst those employed on shore. While of those accommodated in the Sick Bay the number is relatively high (27%). These differences are probably to be explained by the fact that the Sick Bay inmates, although on general messing, are at rest in bed, and get more to eat than their shipmates on duty. It is also of interest to note that the rating obtaining regular shore leave gets but little to eat between his midday meal and breakfast the following morning on the days on which he goes ashore, due chiefly to his tendency to spend his money on beer rather than food. The relatively small number of saturated ratings from the shore base, and the dockyard, is also due to their being older and less fit men generally than the average run of trawler hands, and often also to a dietary fastidiousness in that they do not eat much of the Vitamin C containing foods even when they are available. As a general rule it is observed that those serving afloat have a more plentiful and varied diet than those ashore, particularly so in the case of small ships, provisioned at frequent intervals from their shore base.

An /

An additional factor in producing this greater degree of unsaturation ashore is to be found in the large scale cooking in the general messing galleys, as opposed to the small galleys in the trawlers, where the men's individual idiosyncracies can be catered for. Where unsaturation does exist in the trawlers it occurs in the mild form. In the large galleys ashore the vegetables in particular are stewed for many hours in large cauldrons and the service cook has not yet learnt that the use of soda is to be deprecated. It is thus not surprising that the severer degrees of unsaturation are to be found ashore.

On the other hand the relative proportion of mildly unsaturated cases is higher among the trawlermen than among those employed ashore (68% compared with 48%). If however, the percentage of mildly unsaturated and more severely unsaturated are summated it is seen that the greater number is to be found ashore (85% from trawlers, 95% ashore) the reasons for this are much the same as those given above.

The higher proportion of the unsaturated showing clinical signs, (chiefly Vincent's Angina which for this argument has been taken as a sign of unsaturation(vide infra), amongst the trawlermen (45% compared with 20% ashore), is in keeping with our general experience that among the trawlermen Gingivitis is endemic and many of them suffer from it without reporting and in fact regard the affliction as an integral part of their way of living.

The analysis of Series 2 and 3 show that the majority

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of the ratings on continuous daily dosage of Ascorbic Acid were saturated by the third or fourth day.

ANALYSIS OF SERIES 2.

5 Ratings all in the Sick Bay suffering from complaints other than those associated with Vit.C deficiency.

1 Case saturated from the first day.
(Morning Urine 1.90 mgm%: 6 Hr. Urine 40.0 mgm%)

1 Case saturated from the second day.
(Morning Urine 1.67 mgm%: 6 Hr.Urine 3.23 mgm%)

3 Cases saturated from the third or fourth day.
(Morning Urine 1.43 mgm%: 6 Hr.Urine 1.60 mgm%)

ANALYSIS OF SERIES 3. 10 Healthy Ratings on full duty.

4 Cases saturated by the third day.
(Morning Urine 1.03 mgm%: 6 Hr. Urine 2.22 mgm%.)

6 Cases saturated by the fourth day (two of these possibly by the third day).
(Morning Urine 1.00 mgm%: 6 Hr.Urine 1.14 mgm%)

On the basis of Harris's work 1940 (11) where he states that "any person not reaching the saturation level on the second day of test dosing is regarded as being below standard" it would appear that the ratings as a whole are all mildly unsaturated, a finding which confirms that of Series 1. Were they to be educated to take the proper foods, and to develop a preference for them, this mild degree of unsaturation could doubtless be cured, even in these days of food shortage. The average dietetic history showed that although scarcely any fresh fruit or salad was available to the rating, green vegetables, potatoes, root vegetables and the berry jams were to be had in sufficient quantity to supply the necessary Vitamin intake were their consumption pursued assiduously.

Amongst /

Amongst the already saturated cases were many of the better educated type who consciously picked their food with a view to its health giving properties, while several ratings more or less saturated were found to avoid instinctively the fruits and vegatables, but made up the leeway on vast quantities of jam.

As a general rule it has been noticed that trawlers with a high "mess saving" (in cash) invariably had a bigger sick list and a greater number of mild deficiency states, than trawlers whose crews spent the greater part of their mess allowance upon the food for which it is intended.

Crews with a high mess saving could also be relied upon to produce a larger crop of cases of Gingivitis upon routine medical inspection than would be produced by a crew who spent the allowance on food and consequently were better nourished. The detailed work (unpublished) leading up to this finding was done by one of my predecessors and his results are now included in the general health lectures given periodically to the trawler crews.

A criticism of the results in Series 3 might be made in that the full saturation test was not performed until the fourth day, and thus the oncoming of saturation may have been missed. Harris again 1940 (11) in dealing with this point notes that the resting level of ascorbic acid excretion is an uncertain index of the state of nutrition, so far as any single person is concerned, that there is only a rough and ready correspondance and many individual variations. Judging by /

by the small number of cases in Series 2, where a daily full estimation was performed, the interpretation of Series 3 was made on the basis that any overnight specimen containing 2.0 mgm% ascorbic acid or over was saturated, since in Series 2 this observation held. This simplification of the technique made it possible to carry out the saturation tests on a greater number of ratings than would otherwise have been attained. Amongst those so treated several volunteered, and all confessed on questioning, that while under daily ascorbic acid administration they all felt much better physically, losing the lassitude which is a common complaint generally, and feeling much more active and cheerful than had been their wont.

An interesting paper by Olliver 1940 (Lancet.1940.2.190) gives figures for the amount of ascorbic acid normally found in certain fruits and vegetables and shows they have, when tinned, the same anti-scorbutic value as similar fruits and vegetables cooked by careful household measures. Olliver also concluded that contrary to theoretical expectation, the Vitamin C in fruit is resistant to the heat treatment in jam making. It would thus appear that the degree of deficiency demonstrable in this Naval community, can be made good by intelligent arrangement of the general messing, and by educating the ratings to pick their food with an eye to its dietetic value and by the use of tinned and dehydrated vegetables when fresh vegetables are unobtainable.

The fourth part of this investigation, that of correlating /

correlating capillary resistance and Vitamin C subnutrition was not very successful, chiefly due to errors in technique, and a failure to appreciate the subtleties of the test. A glance at the figures will show that in the great majority of cases no petechial haemorrhages were seen at all, although the majority of the ratings were proved to be unsaturated with Vitamin C. On the other hand there were certain cases with a high count of capillary haemorrhages and yet almost saturated with Vitamin C.

The results are thus contradictory if viewed in the light of the older theory of the association of Vitamin C subnutrition and capillary fragility. When taken, however, in relation to the later theory of the association of Vitamin P subnutrition and capillary fragility they are found to be in agreement, although in view of the technical faults, it would be unwise to claim that they are confirmatory evidence of this association.

The explanations of these findings are to be found in the work of Gothlin 1937 (Lancet.1987.2.703) and in that of Scarborough 1940 (Lancet.1940.2.644). In the former paper the standards to be maintained in the measurement of capillary fragility are laid down, in the main they consist of a double arm test at 35 mms. and 50 mms. over pressure, all observations to be made with a 5 dioptre lens in full daylight or with a "daylight" lamp, and the investigator to have full visual acuity. These standards were further investigated, and their value confirmed by Bell, Lazarus and Munro in 1940 (Lancet /

(Lancet 1940.2.155). If they are not adhered to many haemorrhages go unseen (as in the present series in inferior lighting) or too many may be seen.

In their paper Bell, Lazarus and Munro concluded that a Vitamin C deficiency was demonstrable by an increased capillary haemorrhages count, but suggested that other factors also were involved. Later work (see below) has confirmed this.

Scarborough 1940 amplified his work by a study of six patients, chiefly chronic alcoholic, middle-aged batchelors, with clinical scurvy, and showed that although the sub-cutaneous ecchymoses typical of scurvy were a sign of Vitamin C deficiency, the increased capillary fragility, as demonstrated by a capillary resistance test, as performed by Göthlin, was not a sign of Vitamin C deficiency, and did not respond to the administration of ascorbic acid, but did respond to the oral application of the Vitamin P (preparation Hesperidin Glaxo Ltd., 1 grm. daily), and was in fact a sign of Vitamin P deficiency. He summarises his paper as follows "A deficiency of Vitamin P may exist in man even when he has been taking large doses of ascorbic acid for prolonged periods.

The clinical manifestations of Vitamin P deficiency include pains in the legs on exertion, pain across the shoulders, general weakness, lassitude and fatigue. It is invariably associated with a much decreased capillary resistance, and may be characterised by the development of spontaneous haemorrhages especially in areas exposed to pressure. It has not been found to be accompanied by any haematological /

haematological abnormality. It responds to treatment with Vitamin P. The precise chemical nature of the Vitamin remains to be determined".

In the light of this work it would thus appear that 5 of the present series of cases irrespective of being deficient in Vitamin C are also deficient in Vitamin P. On account of the technical faults mentioned above, however, many cases have probably been missed, the number would then be greater.

Although further original work on this aspect of the subject was not possible - it is of interest to trace the investigations which led to the formulation of the existence of Vitamin P and to outline the different views held on the relation of this Vitamin and capillary fragility.

Early significant work is that of Rusznyak and Szent-Gyorgi in 1936 (Nature 1936.27.138). The above authors describe shortly the stages leading to the "assumption that ascorbic acid is accompanied in the cell by a substance of similar importance and related activity". In the absence of both of these substances symptoms of the lack of ascorbic acid prevail (i.e. Scurvy) and conceal symptoms of the lack of the second. The condition of increased capillary fragility is cured by the administration of the extract of Hungarian Red Pepper or Lemon Juice and the active substance responsible is found at the end of fractioning to be practically pure flavone or flavone glucoside. The flavones are a group of vegetable dyes and play an important role in animal life and are of a vitamin nature. They propose the name /

name Vitamin P for them.

A further paper by the above authors (co-opting Bensath), (Nature 1936.798.138) amplifies the above remarks and attempts to establish the vitamin nature of the flavones. In this they describe experiments on guinea pigs on the Shermann-La Mer-Campbell scurvy diet in which one group is fed on added "Citrin" - this being the crystalline flavone fraction of lemon juice. The Guinea pigs without "Citrin" lost weight rapidly, had numerous haemorrhages into the costo-chondral joints, intestinal mucosa and articular surfaces generally, together with fragility of the bones, looseness of the teeth etc. and died about the second week with a marked pre-mortem fall of weight. Those on "Citrin" (1 mgm. daily) showed symptoms of scurvy, but the loss of weight was much more gradual and there were far fewer haemorrhages, while they died, after the cessation of the administration of "Citrin" on the sixth week. On the basis of these experiments the afore mentioned authors conclude that experimental scurvy, as commonly known, is a deficiency disease caused by the combined lack of Vitamin C and P. Pure Vitamin C deficiency can be observed only when Vitamin P is administered to Guinea Pigs on a scorbutic diet. Pure Vitamin P deficiency cannot on the other hand be demonstrated in Guinea Pigs.

In 1937 Zilva (Biochem.Journal 1937.31.915) summarises the above work and adds several corroborating findings of his own. Satisfactory results were obtained by treating with "Citrin" 3 cases of vascular purpura, 4 cases of thrombo-cytopoenic purpura, 7 cases of infectious disease,

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1 case of myxoedema and 2 cases of diabetes with markedly lowered capillary resistance.

Further chemical investigation revealed that "Citrin" was not a pure substance but consisted of a mixture of crystals of hesperidin and an eriodictyol glucoside, with the former predominating. It was found in addition that hesperidin or an impure sample of demethylated hesperidin i.e. the "Mother Liquor" of Citrin, possessed Vitamin P activity in Guinea Pigs whilst the chemically related quercitrin did not. Zilva thus summarises the results to date as follows. "The administration of a daily dose of 1 mgm. of "Citrin" or a mixture of 2/3 mgm. hesperidin and 1/3 mgm. eriodictyol or of 1 mgm. of purified hesperidin did not delay the onset of scurvy or the fatal termination of the disease in guinea pigs on a scorbutic diet. The post-mortem examination of these animals revealed typical scurvy characterised by extensive fresh haemorrhages".

The administration of a daily dose of 0.1 to 0.2 mgm. ascorbic acid, doses lower than the minimum prophylactic dose, to guinea pigs on a scorbutic diet produced a pathological condition resembling that obtained by Szent-Gyorgi and his colleagues by the administration of a daily dose of 1 mgm. of "Citrin" or of "Hesperidin" to these animals when maintained on a scorbutic diet.

The next link in the chain is forged by Göthlin in the paper quoted above (Lancet 1937.2.703) when he discusses the question as to when capillary fragility is a sign of Vitamin C /

C subnutrition in man. Here in addition to laying down the conditions for the technique and standard examination for capillary fragility, he concludes that the estimation is useful for determining Vitamin C subnutrition in mass investigations but is only of accuracy in healthy persons - while in those under capillary poisons, histamine, neo-arsphenamine etc. or with chronic ailments it is necessary to have a second observation after doses of ascorbic acid.

In 1938 Scarborough and Stewart (Lancet 1938.2.610) showed by charts that the oral administration of "Hesperidin" can reduce the number of haemorrhages in patients with vitamin deficiency. This effect was observed when petechial haemorrhages were induced by the application of pressure and also in cases exhibiting spontaneous haemorrhages after the administration of arsenic or bismuth (haemorrhagic capillary toxicosis of Frank). It appears in these cases to be independent of the presence of ascorbic acid in the diet.

This work was amplified in 1940 by Scarborough (1940 Lancet.2.644) who concluded that Vitamin P does not control the large subcutaneous haemorrhages characteristic of the scorbutic state. These haemorrhages are arrested within 24 hours by a large dose (500 mgm.) of ascorbic acid. The administration of Vitamin P has no effect upon the other important manifestations of the scorbutic state i.e. tissue dehydration, anaemia, knee flexion and the general clinical condition. The administration of Vitamin P can produce an increased capillary resistance in the scorbutic subject either

before or after treatment with ascorbic acid. The capillary resistance of such subjects is not controlled by the administration of ascorbic acid or of Vitamin A,, B. or D.

The other point of view in the form of a critical analysis has been put by Bell, Lazarus and Munro (1940 Lancet 2. 155), who throughout this research lay greater stress on the value of capillary fragility tests in the assessment of Vitamin C subnutrition than do the Edinburgh School. They summarised their work in 1940 as follows.

(1) The fragility of the capillaries of the skin of the antecubital fossa was examined by Göthlin's method in a series of 346 healthy British students.

(2) Variations in the illumination alter the mean number of petechiae detected. A 300 volt lamp at a distance of 2 ft. proved to be a good standard illuminant.

(3) Petechial counts of under 8 were found in 89.3% of cases. Under the conditions of the tests 8 petechiae or more may be regarded as unusual; this agrees with the opinion reached by Göthlin as the result of his work on Scandinavians.

(4) In most cases where the petechial count was 8 or over the ingestion of Vitamin C reduced the petechial count to less than 8 in 2 weeks. The ingestion of Vitamin C has no effect on counts below 8.

(5) The ante-cubital fossa was found to be as suitable as the forearm for this test.

(6) There are a few healthy persons (5 in 346) with increased capillary fragility who are not influenced by the administration of Vitamin C or Vitamin P.

(7) /

(7) Apart from abnormal influences e.g. fever, administration of heavy metals - two factors influence capillary fragility in health, i.e. menstruation (which increases the count) and ascorbic acid (which maintains the count at a normal level). The present study suggests that other factors are also involved.

In 1941 Khan and Muir (B.M.J. 1941.1.752) carried out a similar investigation of 40 unselected children from 3 different social classes. Of 8 with revised petechial haemorrhage counts, 7 were made normal in 1 week on 100 mgm. ascorbic acid daily and the remaining 1 was made normal in 2 weeks. From this they conclude that the test is of value in assessing the degree of Vitamin C subnutrition in children. In their summary they quote much of the evidence referred to above and also include the following finding of Göthlin, noted as far back as 1931, where it was found that 5.9% to 21.5% of Göthlin's children gave a positive capillary resistance reaction. In all cases their diets were deficient in Vitamin C. These children were given 60-120 cc. orange juice daily and yet only 50% of them showed any definite rise in capillary resistance. From this it was concluded that although lack of Vitamin C was a definite factor in lowering the capillary resistance, there were other factors to be considered.

That these other factors involved Vitamin P was once more shown by Vacek V. (Schweiz. Med. Wochenschr.1941.71.153), who found that the administration of citrin in doses of 20-40 mgm. given /

given parenterally or of 200-240 mgm. given by mouth increased capillary resistance as judged by the tourniquet test, and shortened the blood clotting time in both normal and sick individuals, but had no effect on bleeding time or on the number of platelets. The effect of an injection of citrin reached its maximum in from a half to two hours and passed off after 2 - 5 hours.

Further additional evidence that capillary fragility and Vitamin C are not closely inter-related has just come to hand in a paper by Munro, Lazarus and Bell (1942. Lancet. 1. 648) in which they investigated 182 normal healthy students on a war time diet and compared the results with their previous group (referred to above) on a pre-war diet, when they found no significant difference between the two. This is of great interest since it has been shown in numerous surveys, including my own, that the great majority of the population, are markedly deficient in Vitamin C and when taken in conjunction with the survey of Widdowson and Alington in 1941 (1941. Lancet II.361) where they found that the Vitamin C content of the average diet had been reduced from 57 mgm. per day in 1935 to 27 mgm. per day in 1941 would further substantiate the fact that capillary fragility tests are not an accurate nor sound measure of the state of Vitamin C subnutrition and thus corroborates the findings of Scarborough, Szent Gyorgi and others that Vitamin P deficiency is adequately demonstrated by the capillary fragility test while Vitamin C subnutrition is best discovered by means of the ascorbic acid urine saturation test. A corroborative side light in this view is /

is to be found in Crandon, J.H. Lund & Dill (1940 New Eng. J. Med. 223-353) where it was pointed out that it is possible to maintain normal nutrition when the intake of protective substances is erratic. Crandon himself, even when on a Vitamin C free diet showed no signs of scurvy till after 5 months but even in the presence of frank scurvy the Göthlin capillary resistance test was negative.

Zilva (1942 Biochem.J.35.1240) also supports this view that the body reserves of Vitamin C are considerable and even when the normal intake is depleted it is some considerable time before frank signs of the lack begin to show themselves. It may well be that the general metabolism re-adapts itself to the lower level of Vitamin C saturation and our figure of 27% only of the unsaturated showing clinical signs is thus in support of this view. Personal experience of life in a destroyer in the Arctic is also in agreement. Following a long period - 3 months - more or less steady sea time on basic rations only - patently deficient in Vitamin C and without using the supplementary ration of raw lime juice, a situation was produced in which all were seen to be pale, easily tired, but showing no other clinical signs of the lack. At the end of this time a consignment of fresh apples and oranges were received and it was found that the steady consumption of these rapidly produced signs of intolerance (i.e. the body metabolism had become unadapted to their presence), in the form of nausea and diarrhoea and in many cases the inclination to consume fresh fruit was found to have disappeared, many members of the crew failing to take advantage of the fresh consignment.

Evidence /

Evidence that our general resistance to infection had markedly fallen was also seen. During these three months the incidence of the common respiratory infections was practically nil, chiefly due to the absence in these cold and rarified latitudes of the causative organisms, but as soon as the ship returned to home waters and arrived within 50-60 miles of the British coast an epidemic of common colds, sore throats, conjunctivitis etc. occurred and when the ship arrived in port there was hardly a rating aboard who was not involved. By the time we had come to anchor there were, in addition, two cases of pneumonia and one of acute bronchitis which had to be discharged to the hospital ship.

Night blindness amongst the watch keeping officers was also found to be increased, but here the added factor that during these months we had encountered no darkness had also to be borne in mind. It took some weeks to become re-accustomed to the black-out conditions surrounding these islands.

This gradual falling of the powers of resistance due to sub-optimal feeding, the infrequency of adequate exercise and the absence of a reasonable quantity of sunshine (the ship went straight to the Arctic after a winter in the North Sea) provides a good illustration of the insidiousness of the fall of the tissue ascorbic acid. At one stage the question of issuing raw lime juice daily to the ships company was considered and eventually turned down on the grounds that (a) there was only a limited quantity on board and future supplies uncertain and (b) /

(b) there had as yet been no cases of scurvy. In the light of the present work we would have been wiser had we advised strongly such an issue (but vide infra).

The estimate of our own ascorbic acid excretion (included in Series 1 and done shortly after leaving this ship) is a good indication of the levels of submutrition that must have been reached by the majority of the crew and also explains the abnormal degree of exhaustion that followed an unaccustomed 3 mile walk on one of our rare afternoons ashore. In our own case it took 5 days to become saturated, 700 mgm. Ascorbic Acid being consumed daily, thus indicating a fairly marked degree of unsaturation. The gums were also noted to bleed on cleaning and one of the Officers developed a severe Vincent's infection. Further inquiry has led to the discovery that naval "lime juice", except in specimens containing "lemon juice" contains apparently no appreciable quantity of Vitamin C. Hence the issue of the "lime juice" carried would have been of little or no value. This was not realised when at sea.

These findings are in agreement with recent work indicating that Ascorbic Acid may play a direct role in bodily resistance to disease.

Harde & Thompson (1935 Compt. Rend. Acad. d. sci. 200. 1425. quoted by McCollum et al. in "The Newer Knowledge of Nutrition" 1939.431) suggest that complement may contain Ascorbic Acid as a component since the thermolability of both substances is similar. After histamine shock the content of complement and ascorbic acid in the blood was reduced.

Injection /

Injection of Ascorbic acid led to a significant rise in complement. Marsh (1936 Nature 137. 618) has reported that the "complement complex in the blood of the guinea pig disappears or suffers reduction in titre when ascorbic acid is withdrawn completely or partially from the diet. Moreover he states that the complement titre can be restored to normal by means of a diet rich in ascorbic acid. Horgan's (1936. Nature 137.872) observations are in complete agreement with those of Marsh.

The studies of Ecker and associates (Ecker,Pillemar, Wertheimer and Gradis. 1938. J. Immunology 34.19,39,45) who, using improved methods of titrating complement, have demonstrated a marked decrease in complement parallel with the reduction in ascorbic acid of the serum. Administration of ascorbic acid to scorbutic guinea pigs increased the complement titre.

CONCLUSIONS:-

This review would thus show that the majority of the Ratings in this community are mildly deficient in respect of Vitamin C a finding reciprocally corroborated by the results in Tables 1, 2 and 3 and that 25% are more severely unsaturated.

All these Ratings are men who have been medically passed as men fit for service, and although admittedly there is a certain percentage amongst the shore personnel who are less fit, being passed for shore service only (for various reasons) yet the class of men as a whole represents a so-called fit sample of the general community. Yet 85% of them are unsaturated with Vitamin C, while amongst the community living on shore the figure rises to 95%. It is therefore manifest that amongst the civilian population, where the standard of feeding is neither so good nor so adequately controlled, the proportion of the unsaturated must be very much higher and is probably more in the region of 95-98%. Confirmatory evidence that this deduction is well founded has just come to hand in Harris's most recent paper (Harris, L.J. Lancet 1942.1.642), in which he surveys groups of children on a war time diet, and in the evidence of Francis and Wormall (Lancet 1942.1.647) who surveyed groups of medical students. Harris summarises his paper as follows. "Children at a poor class elementary school and at a well conducted residential institution were examined for their levels in Vitamin C. As in previous surveys, those at the institution were found to be at a higher level than those from poor homes. Both groups were, however, considerably /

considerably lower than the corresponding groups examined before the war (for example in 1938-39). The difference is attributed to the decreased supply of foods rich in Vitamin C.

A considerable seasonal fluctuation was noted at the residential home, levels being low after the winter and much better after the summer when foods rich in Vitamin C are more readily available.

Control groups who had been given graded supplements of synthetic Vitamin C with their daily dietary for some months were found on test to be correspondingly graded in their Vitamin C levels. This gives further evidence of the reliability of the method of test.

Middle class university students and scientific workers seemed on the whole to have been affected less than the poorer children in their "reserves" of Vitamin C, but again there was evidence of a strong seasonal tide, the level of members of a Womens' college examined at the end of the summer being highly satisfactory".

Francis & Wormall in surveying groups of medical students at St. Bartholomew's Hospital give very similar results. 87 subjects were examined between May - July, 1939, 42 in July and September, 1940 and 52 in June and July, 1941. The results suggest that as far as "saturation" with the Vitamin is concerned the condition of these subjects after the first 9 months of war was not significantly different from that of a similar group 12 months earlier. In June and July, 1941 (about 21 months after the outbreak of war) however, the subjects /

subjects showed a much greater degree of unsaturation and this deficiency was on an average about 1½ large doses per subject (equivalent to about 1.5 gm. of the vitamin). It would thus appear that the country as a whole is skating on the somewhat thin ice that separates it from a scorbutic catastrophe and were it to be suddenly exposed to a sudden worstening of the dietetic situation, a situation calling for increased activity and exertion, as might happen in the case of (say) invasion, then it is highly possible that clinical scurvy itself would make an appearance and perhaps seriously impede the national effort.

Harris again (1942 Lancet. 1. 644) in considering the various criticisms of the method of test supports this view. He writes as follows "Even if we accepted (which we do not) the thesis that absence of scurvy means sufficient Vitamin C the saturation test would still be useful for ascertaining whether a subject was near the scurvy level or far removed from it. The actual onset of scurvy is sudden and it is accordingly dangerous to disregard the evidence which can be obtained of its approach. A parallel with Vitamin K may be drawn: an individual with a pro-thrombin value of over 20% will appear normal on casual inspection, but when the value drops to 20% haemorrhages will abruptly supervene. Failure to take the precaution demanded by the laboratory finding is not justified".

The finding that 27% only of the cases showed any clinical signs (recognised and unrecognised) of Vitamin C lack /

lack is adequate proof of the insidiousness of the increasing deficiency and gives support to the belief that a superficially healthy population might quickly be toppled over the brink of the precipice marked scurvy. The views of Crandon, Lund and Dill (25) and of Zilva 1942 (26) that the maintenance of normal nutrition is possible even when the intake of Vitamin C is erratic must also be borne in mind in this connection. Minot and his co-workers (J. Pediat 1940.16.717) have confirmed the finding of other investigators that if there is 0.7 mgm% or more Ascorbic Acid in the blood serum, the nutritional state in respect of Vitamin C is satisfactory and also state that values of 0.3 mgm% - 0.7 mgm% indicate a restricted intake and may or may not be associated with any serious undersaturation of the tissues, whereas values under 0.3 mgm% indicate a serious deficiency.

Although in the present series of cases it has not been possible to perform any blood estimations the results by the excretion method would suggest, in view of the above work, that the majority of the cases had blood ascorbic acid values in the 0.3 mgm% to 0.7 mgm% group, thus indicating a restricted intake - while some of the cases at least are approaching the 0.3 mgm% limit.

On the other hand a certain amount of work has been done in which the conclusion is reached that these low unsaturated levels do not necessarily indicate the presence of deficiency disease. Difs. (Acta.Med.Skand.1940.suppl.110) finds it difficult to believe that unsaturation of the tissues denotes the /

the presence of deficiency disease and this opinion is confirmed by Holmes and co-workers (J. Pediat. 1941.18.300) and thus giving added weight to the views of Zilva 1942 and of Crandon, Lund and Dill, 1940.

It is thus necessary to turn to other aspects of the subject before a considered opinion can be expressed on the significance of these low values. There are several other accepted signs of a low nutritional state, such as tiredness, lassitude, lack of energy, loss of appetite, mental apathy and in children general retarded development. Is this not a picture which might well be summed up in the expression "Service Inertia" - a very general complaint which applies as much to the civilian as to the service personnel in wartime.? If this be so, then one of the factors responsible is submutrition.

Lund (J. Amer.Med.Assoc. 1941.116.663: and New Eng.J. Med. 1940. 223, 353) has obtained evidence of the beneficial effects of Vit.C therapy on wound healing. If therefore this naval community were seriously deficient in Vit. C it would be expected that the steady stream of minor injuries and accidents, with which we have had to deal, would take longer in repair than normal. Although no accurate investigation on this point has been performed in the present series, our own opinion and that of our colleagues is that healing processes as a whole have not been retarded (stitches from minor cuts are usually removed on the 4th or 5th day) and thus the low level of Vit.C saturation present would not appear /

appear to be of very great significance in this connection. Another aspect indicative of a general lowered resistance to infection and thus of a subnutritional state is the frequency with which common respiratory infections are not clearing up with their normal celerity. The common cold during the winter and spring lasted in many cases from 3-4 weeks and is inclined to run the gamut of its associates such as pharyngitis, laryngitis, conjunctivitis and blepharitis and even mild bronchitis and bronchial catarrh before stimulating anti-body formation to a pitch sufficient to annul the infection. Is not also the much discussed increasing incidence of pulmonary tuberculosis bound up with the same problem (Laidlaw & Macfarlane B.M.J. 1942.2.63).? Heise & Martin (1936 Proc.Soc.Exper.Biol.et Med.35.332) estimated the urinary ascorbic acid excretion of 54 patients with mild, moderate and advanced tuberculosis using Tillman's titration method. The diets were all presumably adequate. The data was classified in 4 arbitrary groups in order of their magnitude. The number of patients with active tuberculosis was then determined for each group with striking results. Six patients excreted 0-0.5 mgm. daily, five of these had active tuberculosis and it is believed that the sixth had some degree of activity. Fourteen excreted 5-8 mgm. daily and active infection was present in nine of the fourteen. Twenty-one excreted 8 to 14 mgm. daily and only seven of the twenty-one showed activity. Finally in the group excreting over 14 mgm. daily only one of the thirteen showed activity. From these results it was thought that tuberculous persons require a larger /

larger intake of ascorbic acid in order to maintain a normal ascorbic acid balance.

It is also possible that the increasing frequency of toxicity to Arsenical preparations administered in the treatment of Syphilis is likewise allied to Vitamin C subnutrition (Cormia, F.E., Canad.Med.Ass. J. 1937.36.392), (Salzberger & Oser 1934.Proc. Soc. Exper. Biol. et Med. 32. 716), (Perla & Marmoston 1937 Proc. Soc. Exper. Biol. et Med. 32. 716).

It is however, straws which show which way the wind blows and our own opinion is that the population as a whole is running on a low basic Vit. C level, which would not need any great extra strain on it to produce serious and widely distributed symptoms and that the time has come when it would be wise to consider the value of several shiploads of lemons and oranges as vital war material, and a campaign to produce such fruit as tomatoes at home be opened - the scale aimed at being the consumption of one Vit. C bearing fruit per day per head of population. The most generally accepted estimate of the daily requirement of Vit. C in the adult is 50-60 mgm. daily. Widdowson and Allington's dietary survey (Lancet 1941. 2.361) is of importance in connection with this figure, for they showed that the Vit. C content of the average diet has been reduced from 57 mgm. per day in 1935 to 27 mgm.per day in 1941. Should it not be possible to issue Vit. C in its natural state (the most easily assimilable form) then it would be a wise policy to issue it as ascorbic acid tablets (50 mgm) - 1 per day at least to the fighting services. In control tests in Germany during the war the provision of 50 mgm.of synthetic ascorbic /

ascorbic acid daily for school children as a pro-phylactic has increased resistance to infection and accelerated physical development (Bull. War Medicine 1941.2.6.).

Unfortunately the cost and the complicated plant necessary for the production of synthetic Vitamin C makes such an issue impracticable, and reliance, which is well founded, has to be placed upon the proper use of potatoes, cabbage, brussel-sprouts and kale, all of which can be grown in this country throughout the year and can be used in rotation.

The production of dehydrated vegetables, now commencing on a large scale, will also appreciably relieve the situation.

An interesting leading article in the B.M.J. (1942.i.726) condemns the wholesale empirical distribution of vitamin tablets, as has been advocated by many drug firms in the U.S.A., on the grounds (a) that such a step is unscientific and (b) gives a false feeling of security in industry. They suggest that monies so expended would be much better spent in the support of a thoroughly scientific investigation of sub-nutrition generally. They quote the survey under war conditions in Germany, quoted above (Quartr. Ernauhrung.1941. 6.269.). This shows that the health of children and adolescents may be improved by the administration of Vit. C and that notably the resistance to infection in general is increased and the duration of respiratory infection shortened. The German observations are particularly striking because of their enormous scope - they include over two million school children /

children, It is noteworthy that this Vitamin treatment is looked upon there only as an emergency prophylactic measure to be replaced as soon as circumstances permit by a balanced complete diet of natural foodstuffs. Some such scheme or modification thereof is patently obvious and since this is going to be a long war, would be a wise and far seeing policy.

Organisation of the existing supplies of Vitamin C would however, greatly help the situation. This can be done in two ways. Cooking of green vegetables should aim at the preservation of the maximum Vitamin content (a) by preventing prolonged boiling in large cookers as frequently happens in the services and (b) by avoiding the use of soda to preserve the colour of the vegetables. This is still a common practice in service galleys. The second method aims at spreading the existing vitamin stock throughout the year. In the summer fresh green vegetables and raw salads are plentiful and their consumption in the raw state is to be encouraged. During the winter and spring potatoes and the vitamin rich jams, such as strawberry, raspberry and blackcurrent, should be used, the vitamin poor jams such as plum, apricot, peach etc. being reserved for summer use only. Properly tinned and dehydrated vegetables should also be reserved for winter use, for as Olliver has shown (1940.Lancet.2.190) they have the same anti-scorbutic value when tinned as do similar fruits and vegetables when cooked by careful household measures.

The Lancet (1942.2.130) draws attention to an article by Morgan, E.J. (Nature Lond.1942.92) who claims that parsley much exceeds /

exceeds watercress as a source of vitamin C. He gives the figure of 280 mgm. ascorbic acid per 100 gm. in nine samples of parsley leaves gathered in Cambridge this spring. Olliver (quoted above) gives 61 mgm. per 100 gm. as the average figure for watercress. That parsley can be given all the year round is pointed out. It is stated that chopping with a sharp stainless steel knife reduces the ascorbic acid content of parsley by 20%. A recipe for parsley lemonade is given. An ounce of picked leaves are pressed down in a jug, ½ pint of boiling water is poured on and allowed to stand for 2 minutes and the whole is then squeezed through muslin or calico. This produces a cloudy, lemon yellow infusion containing 40-56 mgm. of ascorbic acid (equivalent to the juice of an average orange) and tasting only slightly of parsley. It can be flavoured by one of the lemon substitutes.

Harris (The Practitioner 1940.145.105) in dealing with the prevention of dietary deficiency disease points out that it could be hard to find a better emergency ration than that reported to be used by the Finnish soldiers - unpeeled lightly cooked potatoes prepared with milk and butter.

SUMMARY:-

An account is given of an investigation into the ascorbic acid excretion of 100 Ratings all more or less healthy, in an attempt to assess the degree of hypovitaminosis C present in this base. It was found that 15% were saturated, 60% were mildly unsaturated, 25% showed a more severe degree of unsaturation, and that among the unsaturated 27% only showed clinical signs.

A review of the literature, and previous work on the subject is given.

The correlation of capillary fragility, and Vit. C subnutrition was also attempted, and its relationship to Vitamin P deficiency discussed.

A discussion of what the valid conclusions are is entered into and various methods of combating the deficiency suggested.

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Plate I.

Initial lesions of Vincent's Gingivitis.

Plate II

Vincent's Gingivitis in maxillary molar region.

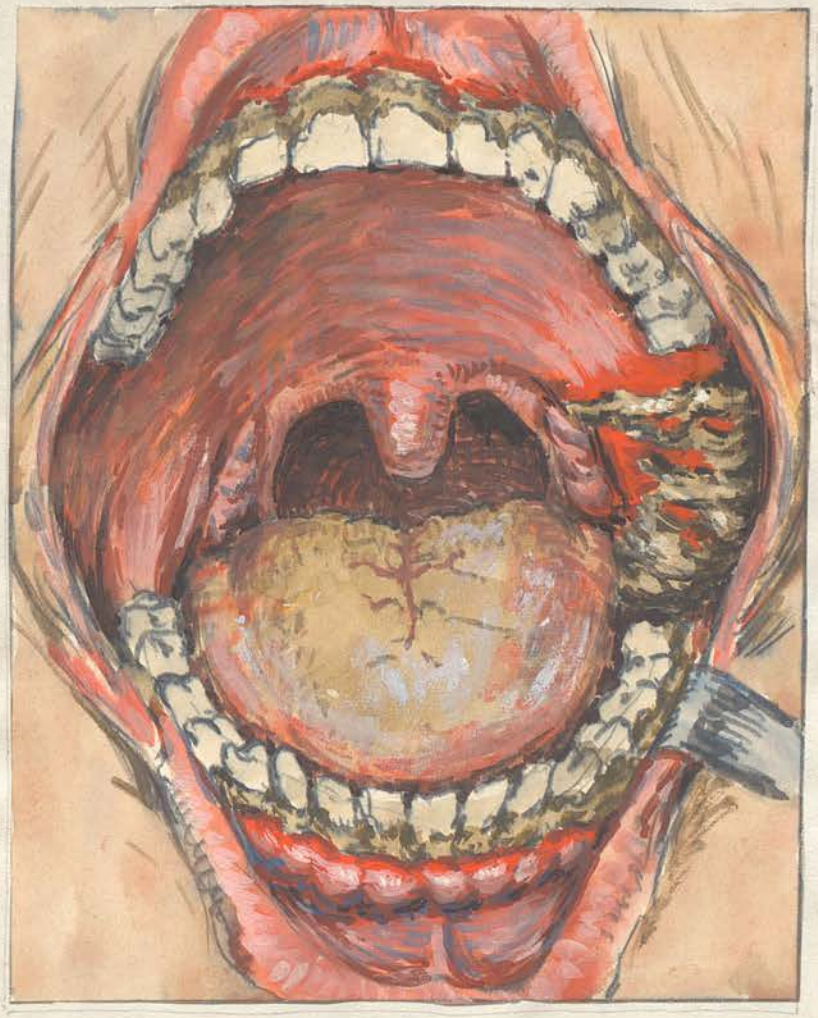

Plate III

Severe Vincent's Gingivitis.

PART II.

ASCORBIC ACID SATURATION and its relationship to INFECTIVE GINGIVITIS.

A review of thirty-six Cases.

As has been mentioned in Part I Infective Gingivitis has been noticed to be endemic amongst the trawler hands at this base. A large number of cases pass through the Sick Bay, chiefly in the late winter and spring, and in the normal course of events are referred to the Dental Officers where they are usually treated by local applications, and returned to duty. While carrying out the investigations of the level of Ascorbic Acid saturation amongst the healthy ratings enumerated in Part I, several references were found in the literature to an association between Infective Gingivitis and Vitamin C. Subnutrition, and evidence was to be found that Vitamin C subnutrition was the underlying factor in most cases. It was said that unless this nutritional failure were attended to, the cases invariably recurred when treated by local applications only. On the other hand several Authors stoutly denied any such association, maintaining that the condition was purely infective in origin and being contagious, was spread by such means as improperly washed drinking vessels, feeding utensils and such like and by direct contact, such as kissing. They stated that any one exposed to these conditions was liable to contract the disease irrespective of their Vitamin C nutrition. A few examples can well be quoted at this stage to illustrate this difference of opinion /

opinion.

Roff & Glazebrook (Brit.Dent.J.1940.68.135), both working amongst naval ratings and using the urinary excretion test as above, in an article on the Therapeutic use of Vitamin C in Gingivitis of adolescents write as follows:- "Advantage has been taken of a trial of the addition of Vitamin C to the diet of boys in a training establishment of the Royal Navy to observe the effects of saturation upon gum lesions. The commonest lesion observed "gingivo-stomatitis" was abolished by the use of the vitamin. The most energetic treatment of recruits leaves a residuum of gum disease in those not saturated with ascorbic acid. Marginal gingivitis, on the other hand, usually responds to simple hygienic measures. The incidence of gingivitis fell more heavily in the Tyneside recruits, and Tyneside is notorious as a "depressed area".

The above Authors quote in support of their argument a German article based on work amongst German army personnel (Kramer J. Deutsch.Med.Wochenschr.1937.12.489). Kramer investigated 34 cases of Gingivitis and Stomatitis for Vitamin C deficiency, according to the method of Jezler & Niederberger (1936). A deficiency varying from 2,000-2,500 mgm. was observed in each case and treatment with "Redoxon" (Roche) effected a cure in each case except one. He was particularly impressed by the improvement in general health which followed saturation. Not only did the gums become firmer and the haemorrhage cease, but symptoms such as lassitude, anorexia and rheumatic pains in the limbs, also cleared up. Altogether /

Altogether he found that 20% of the army personnel suffered from C hypo-vitaminosis and that the incidence of prescorbutic conditions such as lassitude and pains in the limbs was higher during the winter months, a finding which supports the observation that exposure to damp and cold accelerates the development of scurvy in subclinical cases and is the reason why scurvy was once thought to be due to exposure, as rheumatism is today by some.

Very similar findings are recorded by Campbell & Cook (B.M.J. 1941.1.360). They treated 14 cases of Gingivitis with massive doses of ascorbic acid without any other dental treatment such as scaling or mouth washes. 300 mgm. ascorbic acid was given daily until a urine test showed that the patient was saturated with the vitamin. On an average a total of 2,000 mgm. was needed. The previously sore and inflammed gums became normal after approximately 4 days treatment. They suggest that treatment should be followed by a maintenance dose. Apparently this work was not controlled by gum smears, but they took as their main criterion the prompt bleeding of the gum on pressure and the disappearance of this symptom as a sign of successful treatment. They also noted the persistence of bleeding from the interdental papillae after saturation and clinical cure and suggested a concomitant Vitamin P deficiency as the cause. In addition they comment on the fact that it is necessary to persist with a maintenance dose of ascorbic acid after saturation is reached in order to obtain a complete response.

As /

As examples of the opposite point of view that infective Gingivitis and Vitamin C subnutrition are two independent states, the following papers can be quoted. In "Mouth Infections and their relation to Systemic Disease" by MacNevin and Vaughan (1933 Joseph Purcell Research Memorial, New York) reference is made (Vol. II, p.16) to a paper by Pittenger and Roanohe (The Laryngoscope 1930.40.738). These authors maintain that they have proven the infectiousness of Plaut-Vincent's angina and state that whether or not Vincent's infection is increasing, statistics indicate that it is being diagnosed and treated to a greater extent than it was a few years ago. They find the condition commoner in children and adolescents than in adults, and remark that "this seems to dispute the rule of dental caries, nor did vitamin deficiency nor difficult dentition seem to have any association with the disease". That this is the "official" view in this country at the present moment is reflected in the following extract from "Medical Notes in Parliament" (B.M.J. 1942.1.242). "Sir Ernest Graham-Little reported on February 5th that hospitals in different parts of the country were receiving considerable numbers of patients, drawn from the civilian population and from the Services, suffering from a form of Gingivitis, a precursor of scurvy. Mr. Brown stated that there had been a considerable amount of infective Gingivitis among the Services and some cases amongst the civilian population. The evidence that this condition was due to dietary deficiencies was far from convincing. There was some reason /

reason to think that it was purely infective. Potatoes, carrots and turnips contained the vitamins necessary to protect against scurvy. He was not aware of any difficulty in providing these foods".

In view of this difference of opinion and the high incidence of infective Gingivitis in the ships and shore based personnel under our immediate care the following investigation was planned with a view to determining whether or not it was possible to elucidate the problem further, and to produce confirmatory evidence one way or the other. Throughout the whole investigation the number of cases that could be so used was limited (a) by the requirements of the service, (b) by the number of beds that were available for this experimental work and (c) by the limited duration of naval appointments. The investigation of the ratings submitted to a therapeutic test had to be confined to the summer months, when the wards were not so full, and unfortunately this meant that fewer cases of Vincent's Stomatitis were available than had been the case in the winter.

A review of the Sick Bay returns showed that the incidence during the period 1st January - 31st March was twice that of the period 1st July - 30th September. Our returns unfortunately do not include all the cases, for many of them were referred to the Dental Officer of another establishment, whose figures are not available, and are only shown in our returns as "dental cases". These findings however, taken together with our clinical experience indicate that the infection is commoner during those months following the lean /

lean season for green vegetables.

Having determined the state of Vitamin C saturation of the average rating and the average number of days required for saturation in the healthy, as recorded in Part I, as many cases as possible of Gingivitis were collected and similar estimations performed (Series 4) with the object of determining whether or not the state of saturation in these cases was lower than in the case of the healthy rating. The cases investigated contained those suffering from obvious Vincent's stomatitis, the diagnosis being confirmed by a gum smear, and also included those with manifest pyorrhoea and those whose gums bled on pressure and were spongy to touch but in which bacteriological confirmation was not attempted. In all 36 cases were considered. The results appended in Series 4 were as follows.

Saturated	0 = 0%
Mildly unsaturated	4 = 12.2%
More severely unsaturated (21 confirmed bacteriologically)	32 = 88.8%
	36 = 100%

It was also found that on an average these cases took 5 days to saturate and that the clinically more severe cases took 6 days (Series 5). The correlation of these findings with those of the healthy ratings is to be found in detail in Series 6. In essentials it is to be noted that amongst the cases of Gingivitis none were found to be saturated compared with 15% of the healthy ratings; that there is an increase in the number of more severely unsaturated cases amongst those with Gingivitis than amongst the healthy ratings (88.8% compared with /

with 25%) and that the Gingivitis cases took longer to saturate than the healthy ratings (5-6 days, depending on the severity, compared with 3 days). These findings were thus suggestive of an association of Gingivitis with Vitamin C subnutrition.

The next step was the application of a therapeutic test, for if this association is indeed an entity then the abolition of the subvitamin state should theoretically improve, if not cure the gum condition. It was thus decided to repeat the work of Campbell and Cook referred to above, with certain modifications. In their paper it was noted that the criterion of infection and that of cure were entirely clinical. They took as their main criterion the prompt bleeding of the gum on pressure and the disappearance of this symptom as a sign of successful treatment, but they comment on the persistence of bleeding from the interdental papillae after saturation and clinical cure. In order to eliminate the possibility that this persistent bleeding was not a persistence of infection at a site where debris accumulates and is least accessible to oral therapy, bacteriological gum smears were taken in everyone of our cases and only those that were definite clinical cases of Vincent's Stomatitis or Angina and which gave a positive smear on admission were selected for the therapeutic test. The disappearance of the clinical symptoms together with the production of a negative gum smear were thus taken as a test of cure. Some say that with ordinary staining methods it is not always possible to demonstrate the presence of Vincent's spirochaete and the bacillus fusiformis; but in our experience (all the specimens were stained by ourselves) this demonstration was /

was found to be possible with careful staining. On each occasion two smears were made from the infected area of the gum and in the tests of cure from between the previously infected teeth, and stained, one with methylene blue and the other with Gram's stain, using acetone for decolourisation. The identification of the spirochaete presented some difficulty, owing to its feeble staining reactions, but it was always to be seen on careful focussing in the methylene blue preparation and also, but less strikingly, in the Gram preparation after the eyes had become accustomed to the degree of illumination used. In this connection some maintain that the organisms are only to be found in the severer cases, concluding that the severer the infection the more intense the staining reaction. Stammers in a letter to the Lancet (1942.I.574) states "The conclusion we have reached is that numerous virulent (shown by intense staining) Vincent's organisms can always be demonstrated by suitable stains in acute cases, but that in chronic or subacute cases the organisms are scanty and are very difficult to find owing to their poor staining qualities". In this letter reference is made to a previous letter by Stuhl and Coventry (Lancet 1942.I.153) in which an account is given of the treatment of 50 cases of Gingivitis by a combination of the recognised local, parenteral and Vitamin C therapy with good results. Unfortunately no control cases are quoted. All these cases however, are referred to as giving a negative smear for Vincent's organisms. Stammers suggests that they were thus all either chronic or subacute cases.

Our own choice of case, all giving positive smears, would confirm /

confirm this, except that amongst them were 5 cases of considerable standing which had all recurred following local treatment. Even these were all, when seen, either clinically severe or moderately severe cases, gave a positive smear and thus do not fall into the sub-acute class of Stuhl & Coventry. It has been stated by some (Francis,J.,Amer.Dent.Assoc.1941. 28.1296) that Vincent's Organisms can be seen even in healthy mouths. In order to test this,14 healthy ratings were detailed from a draft passing through the Sick Bay and who had just been passed fit for draft, and smears were taken from their gums. These were stained, one with methylene blue and the other with Grams stain. They all showed the normal assortment of organisms in varying proportions depending on the cleanliness of the mouth, but in only 2 cases could Vincent's Organisms be detected and in one they were sparsely scattered. On examining the gums of these two ratings, the first was found to bleed fairly easily on pressure between the teeth and although no clinical signs of the infection could be detected in the second, he admitted on questioning that his gums did bleed on cleaning. It would thus appear that Vincent's Organisms are not normally present in a gum smear and when detected their presence implies infection of the gingiva.

Campbell and Cook (quoted above) treated their cases with 300 mgm. Ascorbic acid daily and gave no other treatment. It was felt however, that our own cases being of a severer nature, would be handicapped if measures were not taken to remove the quantities of tartar and debris invariably associated, and which were giving the organisms excellent cover. Thus they /

they were treated with 700 mgm. Ascorbic Acid daily accompanied by normal dental hygiene (i.e. teeth cleaning with a moderately hard brush night and morning) followed by a saline mouthwash. They were detained in the Sick Bay, an ascorbic excretion test performed daily until saturation was reached, when the dose was reduced to 100 mgm. per day. If at the end of 3 days after saturation they were still either clinically or bacteriologically active they were referred to the Dental Officer for scaling and syringing with hydrogen peroxide. No other dental treatment was employed and two cases only received intravenous arsenicals at the end of treatment. They were both severe cases and received one dose each.

One case only (Northrop No.12), although clinically cured, failed to give a negative smear from between the teeth on repeated test. This was a severe case on admission, responded well to treatment and since the final smear revealed but a scanty growth of Vincent's organisms, which had a very poor staining reaction, and since it was felt that the rating could not very well be detained longer, he was discharged and the case counted as cured. To date this case has not recurred, but it will be interesting to see whether it should do so.

The ratings were maintained throughout on the ordinary Sick Bay messing and to exclude the possibility that this alone was responsible for cure, 4 moderately severe cases were left as controls (Series 7), being given no treatment apart from normal dental hygiene. At the end of 10 days they showed no signs of improvement, the gums being still ulcerated, painful /

painful and bleeding and still gave a positive smear. The full therapy was then applied.

That this is a sound approach to the subject is supported by Stammers (quoted above). He treated 350 cases of Vincent's infection of the gums in 1941 and concludes that ascorbic acid therapy alone is almost valueless but that in combination with suitable local treatment time in many cases is appreciably reduced. This was particularly noticeable in long standing cases and in this respect his findings were in agreement with those of Stuhl and Coventry. In stating his proposed combination of treatment great stress is laid on the thorough cleansing of the area, including the removal of slough and calculus at the earliest possible moment. Stating that Vitamin therapy is of undoubted value he concludes with the remark that "a suitable tonic seems to be of equal and perhaps greater value in the majority of cases".

In order that the ratings general health should be maintained under as normal conditions as possible in spite of their being detained in the Sick Bay, they were all employed as Sick Bay light duty men on general work about the camp. Their shore leave was stopped while under treatment so that there was no possibility of their obtaining medicaments ashore and treating themselves in addition to the treatment given in the Sick Bay. All their eating utensils were labelled and kept separate in order to protect the other ratings in the Ward. The experimental infection of healthy ratings would have been an interesting line to pursue but it was not considered feasible. The results of this therapeutic test

are /

are to be found in detail in the case histories in Series 5 and the correlation of these findings with those of the healthy ratings in Series 6. These results can best be summarised as follows:-

No.of cases failing to respond to treatment	Nil.
Average No. of days required to saturate (all cases)	5 days.
Average No. of days required to cure clinically (all cases)	14 days.
Average number of days required to cure bacteriologically (all cases but one)	14 days.
No. of cases requiring additional dental treatment of gums to cure i.e. scaling and H_2O_2 syringing.	5 cases.
Average No. of days required to saturate clinically severe cases.	6 days.
Average No. of days required to cure clinically severe cases.	16.8 days.
Range of No. of days required to cure all cases	4 -31 days.
Recurrence rate (as far as is known)	Nil.
No. of cases previously treated by local measures and recurring, were treated successfully by Ascorbic Acid.	5 cases.

From these results certain conclusions can be drawn. From the fact that none of the cases failed to respond to Vit. C therapy and that all cases irrespective of severity showed a marked response, the majority being cured, and the remainder requiring but little dental treatment, chiefly mechanical removal of irritants such as calculus, to attain cure, is evidence of a definite association of Vitamin C. subnutrition and this form of Gingivitis. The marked increase in the percentage of the more severely unsaturated amongst the cases of Gingivitis (88.8% compared with 25% amongst the healthy) is also in support of this theory. The severer the case the longer it took to saturate and the longer /

longer it took to cure, is evidence that the severity of the infection bears a direct relationship to the degree of unsaturation.

It is perhaps rather unfair to claim that none of the cases recurred, particularly since most of the ratings have been lost sight of. They were, however, all instructed to inform us by post should the condition recur and so far none have done so. Many of the cases were discharged as much as six months ago. Five cases (2 of 6 months or more standing) had been previously treated by local measures only and recurring were successfully treated by Ascorbic Acid, thus pointing to the deduction that the demonstrable underlying vitamin deficiency was a predisposing cause.

Throughout it was noted that although the pain was the first symptom to disappear, usually by the second day of dosing with Ascorbic Acid, cases were seldom either clinically or bacteriologically cured by the time saturation was reached and that in order to complete cure a maintenance dose of 100 mgm. ascorbic acid per day was necessary. Two cases only (Jackson, Case No. 2 and Fowler, Case No. 7) taking 4 days to saturate were pronounced clinically and bacteriologically cured in this time. They were both mild cases, with good teeth free from dental caries. No. 7 was a mild recurrent case previously treated by local applications. The majority of the cases were saturated in 5-6 days and cured in 14-18 days on the maintenance dose.

The four cases at the other extreme, all severe clinically, took /

took almost 8 days to saturate and it was not possible to pronounce them cured until 31 days had elapsed on maintenance doses together with mechanical dental treatment. In two of these cases 0.45 gms. N.A.B. was given intravenously at the end of treatment and an immediate effect was produced, thus making it evident that once the underlying deficiency had been remedied, specific anti-spirochetal drugs produce a dramatic result.

A search of the relevant literature was the next step in the investigation. In addition to the papers already referred to, other works were found with a very scattered distribution, much of the work emanating from America.

Two recent text books on the subject appear to take the same view as is outlined above. In the first "Pathology of the Oral Cavity" by L.R. Cahn - Prof. Denistry, Columbia Unversity (1941 William & Wilkins Co., Baltimore) p.148, the following description of ulcero-membranous Gingivitis and Stomatitis is given. This description is so compact that it is worth quoting in full in order that there may be no doubt as to the type of infection with which we are dealing.

"The direct cause of this disease is infection by a complex group of micro-organisms in which Vincent's spirochete and the Bacillus fusiformis play important roles. The pure symbiosis of these two organisms however, is not the specific cause, as D. T. Smith and the others have shown: there must be an admixture of other bacterial forms, among which are a cocci and vibrio. All of these bacteria are anaerobes. They have been grouped under the generic term "Fusospirochetal conglomerate". /

conglomerate."

These bacteria will not produce their characteristic disease without preliminary lowering of the tissue tone, that is, without definite contributory factors. There is a variety of possible contributing factors. These are so important that they must be sought for immediately the disease is noted, for only with their elimination can it be successfully combated. The principal contributing factors are avitaminosis, blood dyscrasias, and hormone imbalance.

There are three areas of predilection through which the infection attacks. Most frequently chosen is the gingiva, especially the interdental papillae. Next, the pericoronal structures of the mandibular third molars are likely to be invaded; and the disease may then spread to the mucobuccal fold, to the tongue, or to the throat. In the latter region ulcers may form on the tonsils or on the fauces, and cause difficulty in swallowing. The condition is then known as Vincent's angina.

Vincent's Gingivitis is usually ushered in with pain and a general feeling of malaise. There is noticeably fetid breath, and occasional rise in temperature, oversalivation, and often difficulty in swallowing. The lymph nodes under the mandible may be slightly swollen and painful. There is a rather typical blood count characterised by an increase in the monocytes, which factor prompts some writers to call the lesion "monocytic angina." The interdental papillae are at first red and swollen. This edema lasts only a short time, for the tissues break down and a membranous slough appears, /

appears, resting on a red rim of tissue sharply demarcated from the rest of the gums.

It is rare for the disease to extend deeply into the underlying structures. For the most part the organisms are enmeshed in the pseudomembrane, where they produce a toxin which causes the malaise. In this the disease is similar to diphtheria. In rare instances the organisms may penetrate deeply into the subjacent bone, producing osteomyelitis and necrosis.

In pericoronitis the disease follows the same course; first edema, then tissue necrosis, then membranous slough.

Histologically, the epithelium becomes necrotic, and fibrin forms on the surface, Enmeshed in this necrotic fibrinous mass are the micro-organisms. A membranous effect is thus produced. Directly beneath this pseudomembrane is a zone of congestion and inflammatory exudate; this corresponds to the red line of demarcation seen clinically. If the tissue is stained by the Levaditi method, fusiform bacilli and spirochetes will be found, not only in the membranous exudate but also in the tissues.

Essentially, Vincent's infection is an acute condition. After the acute phase has passed, the involved interdental papillae are destroyed, leaving punched-out or craterlike areas between the teeth. These areas are difficult to keep clean and hence may act as incubation zones. I have shown that micro-organisms can be found in attacked tissue a considerable time after the lesion looks clinically well. Thus, any factor which lowers tissue tone, such as debris between /

between the teeth, may result in these residual organisms becoming active, and producing if not an acute, at least a subacute phase.

The so-called chronic Vincent's infection of the gingiva is a chronic Gingivitis caused by the accumulation of debris between the teeth in areas where the papillae have been destroyed, the debris still retaining numerous micro-organisms of the fusospirochetal complex".

Sterling V. Mead in "Diseases of the Mouth, p.624 (1940. Henry Kimpton,London) states a confirmatory opinion as follows:-

"Vincent's stomatitis is a disease of the mouth which attacks the gingivae, tongue, cheeks, buccal mucosa, the throat and the tonsils and which produces characteristic ulceration in which a spirilla and a fusiform bacillus are present. It is considered infectious and contagious by many. While this disease is found mostly in unclean mouths, still it does occur in mouths with very slight gingival irritation. Among the factors which may be concerned in the preceptibility of a person to this infection are dietary deficiencies, wasting disease and fatigue, unhygienic care of the mouth, smoking and trauma. The organisms are of the anaerobic type, thriving best in the absence of oxygen. The primary factor in curing this disease is often overlooked when the acute stage responds readily to treatment and the patient is dismissed but returns at a future time with a recurrence of the disease".

Mead lays great stress, in considering these cases, on the /

the investigation of the blood picture, of dietary ("plenty of orange juice and citrous fruits should be given") and of the elimination of septic foci, particularly infected tonsils, sinuses etc. and in the periodontal pocket or a peri-apical infection. He states that in patients with a lowered resistance frequently insignificant areas, such as irritation of the gingival tissues by a gold crown, or by the facing of a bridge, are sufficient to cause an exacerbation of the disease. He also draws attention to the fact that Vincent's infection is more prevalent during the first three to four months of the year than it is during the last three to four months. The average incidence for the first three months is higher than the general average for the year. The average incidence for the last three months of the year is lower than the general average for the year. This finding is in agreement with our own experience in the service.

In the experimental field no papers have been found deal-:ing with the experimental infection of healthy and sub-nutritional humans, but two papers dealing with "Oral lesions associated with Dietary Deficiencies in Monkeys" are available. Topping and Fraser (Pub. Health Rep. 1939.54.416) carefully studied 50 monkeys (Macacus mulatta) in certain deficient states and concluded that "certain of the dietary deficiencies tested are associated with the development of varying manifestations of Gingivitis, stomatitis, periodontal disease and noma".

This work was repeated in considerably greater detail in 1941 by Chapman and Harris (J.Infect. Dis. 1941.69.7). In their /

their preamble they draw attention to the fact that ever since the original publications of Miller (Deutsche Med. Wochenschr. 1884.10.781), Plaut (Deutschr.Med.Wochenschr. 1894.20.920) and Vincent (Ann. Inst.Pasteur.1896.10.488) many workers have confirmed the presence and the quantitative increase of the numbers of the fuso-spirochetal group in these lesions. Experimental infections in various animals have resulted from artificial implantation of the entire flora or at times certain members of the group.

The problem is complicated by the universal observation that fuso-spirochetal flora is usually present in the gingival crevices, smaller crypts and the intestinal and genital tracts of the individual without evident lesions. It has been generally stated that some predisposing factor or factors is essential to the establishment of a Vincent's infection. They enumerate the following:-

1. Primary infections and intoxications such as diphtheria, syphilis, tuberculosis, measles, mumps, streptococcal infections etc.
2. Improper diet.
3. Prolonged fatigue.
4. Chemical poisons, lead, mercury etc.
5. Mechanical trauma.
6. Malignancy, including blood dyscrasias.

In order to test the effect of improper diet, Chapman and Harris elaborated various experiments on monkeys on controlled diets containing different dietetic factors. Thus in a group of monkeys fed on a basic avitaminous diet with added /

added supplements of Vitamins A and D and deficient in Vitamin C they report as follows:- "The average survival time of this group was 88.6 days. All the monkeys on this diet developed oral lesions in the fifth week. The blood serum ascorbic acid determinations became zero at the end of the fourth week. The oral manifestations continued to progress until in some animals necrosis of the gingiva, periodontal membrane and the soft tissue was extensive. In some of the animals there was complete destruction of the periodontal membrane with some osteo-myelitis of the alveolar processes and consequent loosening and loss of teeth. There was a marked increase in the numbers of the fuso-spirochetal groups in all cases".

In addition to this they attempted the artificial transmission to healthy animals.

Material was collected (from animals with severe scurvy) from the necrotic gingiva and periodontal tissue with a blunt curette and scalpel and transferred directly to the traumatised tissue of the healthy animal. Dark ground studies of portions of this material demonstrated tremendous numbers of fusiform bacilli, spirochetes (treponemata and borellia) large non-motile rods and filaments having the morphology of the leptothrix group, motile vibrios and streptococci.

The healthy animals were anaesthetised by the injection of 1.5 cc. of veterinary nembutal into the periodontal cavity. The gums were severely traumatised with a scalpel and one tooth extracted. The necrotic material was directly transferred from the diseased animal and thoroughly forced by means /

means of a probe into the tooth socket and traumatised tissue of the recipient. Every effort was made to produce a condition favourable for a severe extensive infection.

The recipients were maintained on an adequate diet and carefully examined daily until the oral cavity showed no abnormal lesions. There was no other local or general treatment.

The results are described briefly as follows:-
"Two animals developed no apparent infection. The wounds healed within a few days in the normal expected manner. Two animals showed local infections with some ulceration and implantation of the flora proved by dark ground examination. One animal developed a definite local ulceration. These lesions, however, did not extend to the non-traumatised normal tissue of the gums and healed within 16 days with no local or general treatment."

They also draw attention to the findings of Topping and Fraser that they too were unable to transmit the infection to healthy animals.

From these severe test conditions it is thus obvious that fuso-spirochetosis requires an underlying predisposing sub-nutritional factor for development and is thus not strictly contagious in the commonly accepted meaning of the term. Put in another way, they conclude that monkeys maintained on certain vitamin deficient diets develop a tendency to oral lesions, accompanied by an increase in the fuso-spirochetal flora. Monkeys maintained on an adequate stock /

stock diet do not exhibit this tendency. Thus experimental evidence is in support of our thesis.

Further confirmation is to be found in the work of Hanke, M.T. of Chicago (J. Amer. Dent. Assoc. 1930.17.957) in a paper on the relation of diet to general health and particularly to inflammation of the oral tissues and dental caries. In this he refers to a previous paper in 1929 (J. Amer. Dent. Assoc. 1929.16.2263) where he concludes that dental disorders were almost invariably found to occur in persons whose diet is deficient in vitamins and conversely a freedom from dental disorders seemed to be enjoyed by persons eating food that contained an abundance of vitamins. The important factor appeared to be Vit. C. The calcium and phosphate values of the blood were never found to be markedly subnormal, apparent para-thyroid deficiency was never encountered and a marked vitamin D deficiency was the exception rather than the rule.

In 1930 he supplemented this work by a study of 191 cases of Gingivitis and showed a record of improvement in 104 cases when placed on a diet containing added Vit. C or Vitamins C & D. Our own work confirms this, for he noted a deficiency of Vit. C (and often D) in patients with poor gums and / or caries. He summarises his opinion as follows:-

" We are not of the opinion that any syndrome is specifically due to the direct lack of any one vitamin. Many factors are involved in the proper functioning of any body cell and all of the body hormones and all of the vitamins are /

are probably equally important in maintaining a cellular condition that is efficient."

In 1931 he published a further article (Hanke, J. Nutrition 1931.3.433) emphasising the above conclusions, but here stress is laid on the finding that the provision of a pint or more daily of orange juice to a diet otherwise nearly normal not only arrested caries but brought about a marked improvement in the health of the gingival tissues. In this connection attention is drawn to the findings of Höjer (quoted below) relating particularly to the impairment of the health of the blood capillaries in ascorbic acid deficiency. In 1934 Hanke further published the results of a nutritional experiment on over 300 children over a period of two years (Hanke 1934. Univ. Chicago Press "Diet and Dental Health"). This work is quoted by Cady (see below). In this survey the children were examined on their regular diet which was found to be adequate with regard to calories, for one year, at the end of which 60.9% had Gingivitis ranging from mild to severe. At the beginning of the second year one pint of orange juice and the juice of one lemon were added to the daily diet, all the other dietary factors remaining the same. At the end of the second year all but 19% were found to be free from Gingivitis. Evidence for the association of Scurvy with Oral diseases is given by Cady, F.C. (Pub.Health Rep. U.S.Treas. Dept.1937. 52.1526). He refers to the work of Hanke mentioned above and quotes in addition that of Goodrow, W.E. (J. Amer. Dent.Assoc. 1936.23.2159). This latter Author gives an account of an epidemic of Vincent's infection in the San Luis valley of Colorado /

Colorado in 1935 which showed a significant relationship to a possible dietary deficiency. In this valley climatic conditions were not favourable to the production of fruit and vegetables, resulting in a epidemic of mouth infections. Of 9,400 examinations over 3,700 positive cases of Vincent's infection were diagnosed by combined clinical and microscopic examination. Cady (J. Amer. Dent. Assoc. 1934. 21.1099) working in the "Indian Dental Service" reported that in recent years amongst the American Indians in the South West, conditions are very similar to these found in the San Luis valley. He concludes that the high incidence of diseases of the dental investing tissues among the poor and the fact that these conditions are allied so closely to the symptoms of scurvy lend evidence to the opinion that there is an association between sub-clinical scurvy, gingivitis and Vincent's infection and that some of these diseases may be superimposed, as a secondary invader, upon a sub-gingival scurvy. This contention is supported by the group studies and surveys of sections of the population whose diet is low in anti-scorbutic foods, referred to above.

The point of view is further upheld by Harris (Practitioner. 1940.145.105) in a paper on the Prevention of Dietary Deficiency Diseases. He states that Vit. C is needed for the normal elaboration of the enamel, cement and dentine of the teeth. Hence he believes that a deficiency of Vit. C in early childhood, i.e. during the formative period, may be one of the factors responsible for the prevalence of caries among the population in England.

Kellett /

Kellett (Practitioner. 1941.147.714.) in an article on Vincent's infection points out that the condition is more common in early spring and since "the health of the gums is intimately related to Vit. C intake" their condition is likely to be lowest at this time. "Ascorbic Acid is not only the most convenient way of correcting this deficiency but is also one of the cheapest." He deals also in this article with the epidemiological aspect of the subject and gives the following illustrative episode. "Epidemics of Vincent's Angina have been described even in normal circumstances. D. T. Smith, in his monograph, mentions how in a certain un-named hospital a very attractive nurse, developed fuso-spirochetal Angina and within two weeks five of the internes also developed the disease in some unexplained manner."

Further evidence in support of our thesis is to be found in the survey of Crane and Woods (New Eng. J. Med. 1941.224. 503). An account of the same survey is also to be found by Murphy (J. Nutrition 1941.21.527). In this survey a study of the status with respect to Vitamin C nutrition of a group of 86 children, chiefly of French-Canadian extraction, attending an elementary school in a Maine village was made during those months of the year when relatively few home grown fruits and vegetables were available. The results of this investigation showed that of the 86 children 55% had relatively low values (less than 0.40 mgm%) for Vit. C in the blood plasma. 28% had low values both in the autumn and spring, while 27% had slightly higher values (0.40 - 0.79 mgm%) in the autumn but low /

low values in the spring. Such low values have usually been found to be associated with Vitamin C undernutrition. Only two of the children had values that were high enough to be considered evidence of adequate Vit. C intake (0.80 mgm% or above). A comparison of the plasma ascorbic acid values with the results of urinary tests for Vitamin C tolerance in 49 children lends support to the reliability of the plasma ascorbic acid values as an indication of the state of Vit. C nutrition. Examination of the mouths of the same 86 children showed that 29% ~~who~~ had some degree of inflammation in the autumn ~~spring~~ and about 51% (an additional 22%) had inflammed gums in the spring. This inflammation was found to be more frequent in children with consistently low values and the condition was found to improve in approximately two thirds of the 41 children with inflammed gums who were given Vit. C therapy for 3 weeks (200 mgm. Ascorbic Acid daily).

They conclude therefore that Vit. C deficiency appeared to be a factor in the production of the inflammation of the gums observed in these children. In addition they point out that examination did not reveal the markedly swollen, spongy and bleeding gums that are generally recognised as typical signs of frank scurvy, but a milder degree of inflammation of the gums was frequently observed. They noted that inflammation of the oral mucosa was observed most frequently on the labial aspect of the upper jaw, less frequently on the buccal aspects of the maxilla and the labial aspect of the mandible and least frequently on the lingual and palatal aspects.

Although /

Although this work can be taken as favourable evidence, it is only fair to point out that the estimation of the plasma ascorbic acid is a doubtful criterion, since in many cases it has been found to bear but little or no relationship to the urinary excretion findings.

Boyle, Bessey and Wolbach (J. Amer.Dent.Assoc.1937.24. 1768) in a paper on the experimental production of the diffuse alveolar bone atrophy type of periodontal disease by diets deficient in ascorbic acid, note that the histological appearances in cases of peri-odontal disease in man of the type known as diffuse alveolar bone atrophy are almost identical with those found in the peri-odontal tissues of guinea pigs suffering from scurvy. The changes in both cases may be ascribed to the inability of the peri-odontal tissues to form their normal intercellular substances, with resulting inability to compensate for normal wear and tear. They suggest that insufficient intake of Vit. C is an important factor in determining the onset of this variety of pyorrhoea and that the state of Vit. C subnutrition should be examined as a matter of routine before operative measures are taken to relieve it.

A similar opinion is voiced by Fitzsimmons (J. Amer. Dent. Assoc. 1941.28.76). He remarks that a diet decidedly on the acid-ash side contains little Vit. C and that this disbalance has been found in a great percentage of cases of peri-odontal disease. He recommends, that simple mathematical calculation of the acid-alkaline ash percentage is advisable at the beginning of treatment of peri-odontal disease /

disease as it may bring to light dangerous over use of soft "nondetergent" foods. He points out that many foods supposed-:ly containing Vit. C are subject to conditions that easily lower the content of ascorbic acid or completely destroy the acid.

Much evidence in support of our thesis is to be found summarised in "Mouth Infections and Their Relation to Systemic Disease" by MacNevin and Vaughan (1933 issued by the Joseph Purcell Research Memorial, New York). They state (Vol.I. p.349) that clinical and experimental evidence indicate that alveolar atrophy is caused by some disturbance of nutrition. Buchanan (British Dent.J. 1904.25.790) noted that in India, pyorrhoea was most prevalent. Seventy out of Ninety prisoners from the famine district had the disease. Marshall (J. Amer.Dent.Assoc.1927.14.2207) called attention to the prevalence of pyorrhoea among the natives of the island of Tristan da Cunha. He suggests that there is a relationship between the disease and the large consumption of potatoes. The diet is essentially carbohydrate and the food fibrous. No toothbrushes are used and there is very little caries but much pyorrhoea. Further reference to Marshall's work is to be found in "The Newer Knowledge of Nutrition" by E. V. McCollum et al. (1939 MacMillan & Co., New York) quoting B.M.J. 1926.II.399. The islanders' diet is given in more detail as potatoes, eggs, meat and goats milk. Reference to McCollum's tables gives the following Vit. C content for the above diet - milk 0.3 - 2.89mgm/100 cc., Potatoes 11 - 36 mgm%, duck eggs - white 0.3 mgm%., Yolk 1.3 mgm%, meat: oxmuscle

15.8 /

15.8 - 20.1 mgm%, rabbit 0.42 - 1.5 mgm%, sheep liver 25 - 46 mgm%, pig liver 12 - 38 mgm%, pig - supra renal 115 mgm%, rabbit - supra renal 183 - 216 mgm%. Remembering that orange juice contains 63.2 - 70.6 mgm% / 100 ccs. and lemon juice 25.8 - 70.9 mgm. / 100 cc. and lemon peel 100 mgm%, it is seen that the islanders' diet although containing a fair quantity of Vitamin C is probably well below the accepted figure for maintenance of health of 30 - 50 mgm / day. Thus Marshall's findings, although indicative of other dietary factors in the causation of pyorrhoea, suggest that Vit. C lack is one of these factors.

MacNevin & Vaughan (Vol.II,p.353) also draw attention to a paper, amongst others, by MacCollum (Med.J.Australia, 1929. 1.232) who writes on the subject of oral sepsis and general disease from a pathological standpoint. He states that recent evidence indicates pyorrhoea alveolaris to be an essential part of a more general condition of impaired nutrition. Infection, though it may in severe cases produce definite local changes, is in this view secondary. The condition is marked by swelling and recession of the gums, atrophic changes in the alveolar bone, abnormal downgrowth of epithelium along the surface of the cementum and the formation of pockets with or without connections between the gums and teeth.

Wilkinson (1929 Med. J. Australia 1.230) discusses oral sepsis and general health from a clinical aspect. He states that the etiology of pyorrhoea is not well understood, but animal experiments suggest that faulty metabolism plays an important part. The oral cavity also shares in the general lowering /

lowering of resistance to infection, the normal bacterial inhabitants are now able to invade the tissue and produce an inflammatory reaction comparable in every way to pyorrhoea.

Leonard (J. Amer. Dent. Assoc. 1929.16.629) states that early symptoms of periodontoclasia consist of colour changes, contour changes, absence of stippling, subgingival exudate, calculus formation, hyper-sensitivity of the subgingival tissue, deepening of the gingival crevice and haemorrhage disproportionate to injury. Periodontoclasia is largely a systemic disease in his view showing its effects by increased bacterial growth in the mouth, by lowered resistance of the gingival tissues and by poor bone metabolism by which the normal resistance to stress is weakened and reparative changes impaired.

These views although they are general in outline and stated as much as 13 years ago are evidence that the association of oral sepsis and general metabolism were noted at this date, but it is not until recently that Vit. C lack has been more specifically blamed. The next links in the chain of evidence are to be found in the works of those who are more doubtful of the association and in the works of those who frankly repudiate such a relationship.

Weisberger, Young and Morse (J.Dent.Res.1938.17.101.) contribute a study of the ascorbic acid blood levels in dental patients. They investigated the Vit. C nutrition of 65 dental patients using blood plasma levels as an index. They conclude that partial Vit. C deficiency causes some degree of parodontal disease and that replenishment with Vit. C is

followed /

followed by normal ascorbic acid blood values and clinical improvement, of the affected tissues. Unfortunately this review is open to certain criticisms. The patients' diets are described as "low in Vit. C" but no further details are given. The plasma levels are given as follows:- 36 patients 0.00 - 0.57 mgm%, 11 patients 0.60 - 0.85 mgm%, 18 patients 1.00 mgm% or over. As their criterion 0.00 - 0.80 mgm% is taken as "low". This is not the accepted figure and 0.80 mgm% is usually taken as a normal level (see Part I). They stated that "low levels" are always associated with congestion of the gingiva but that in many cases this was limited to a 3 mm. section of the gums, which must have taken considerable searching. On feeding their patients with Vit. C it took 14 days to produce an effect on the gums, although the blood plasma level was normal in 5 days and they do not state whether the patients had any local treatment or not. They do not in addition mention any efforts to control the investigation and since their standards are different from those of others this interpretation is misleading, although their general conclusion would appear to be in line with other work.

The opposing point of view is found in the work of Herlitz, C.W., (Acta.Paediatrica.1939.24.341) working in the Eastman Institute, Stockholm. He investigated the C Vitamin standard in healthy children and in children suffering from Gingivitis, using blood serum estimations in place of urine excretion. From the general examination of these cases, their /

their dietary histories and measurements of serum ascorbic acid before and two hours after test doses in 44 children without Gingivitis and 57 children with severe Gingivitis, he found no evidence of any connection between Gingivitis and a subnormal C standard and concluded that this affection must be referred to some other aetological factor.

Fox, Dangerfield, Göttlich, and Jokl (B.M.J.1940.II.143) working among mine labourers in South Africa and using blood plasma ascorbic acid determinations are also against the association of Gingivitis and Vit. C submutrition. They have considerable doubts as to the efficiency of the urinary excretion test in the native, stating that previous experience of the very low urinary excretion of Ascorbic acid by natives who appeared to be in excellent health, had so shaken their faith in the diagnostic value of this test that it was not adopted as a routine, although numerous isolated estimations were made.

In all they studied two groups, each of 950 native mine labourers, chosen as to be comparable as possible in respect to tribe, age, physical condition and occupation. One group remained on the usual mine diet which was estimated to contain 12.25 mgm. Ascorbic acid per day, while to the other an additional daily ration of 40 mgm. Ascorbic acid was administered in the form of a standardised orange juice concentrate. The experiment was continued for seven months and the behaviour of the two groups was studied in various ways. Both groups maintained a high level of general health, as will be /

be gathered from the fact that, excluding shifts lost by reason of accident, over 99.1% of the possible shifts were actually worked, even by the untreated groups.

Twelve cases of scurvy occurred in the untreated group and one mild case in the group receiving the additional ration of Ascorbic acid. Otherwise no significant difference could be detected in the behaviour of the two groups. Thus the weight changes were almost identical, and there was no evidence that the general health, physical efficiency and resistance to infectious or dental diseases had been increased. The additional ration of Vit. C was discontinued as soon as the patient reached Hospital but there was no indication that the change in the previous diet had improved the rate of recovery from disease or that the rate of healing of wounds and fractures had been accelerated. Nearly three quarters of the individuals examined by the Dental Surgeon in both groups were found to possess healthy gums. One hundred and fifty-nine were examined in the control group and 72.3% were found to have healthy gums, while of the 64 cases examined in the treated group, 70.3% were found to have healthy gums. "It will be seen that in spite of the low amount of Ascorbic acid in the diet of the control group and the highly depleted state of their reserves, the majority possessed healthy gums and there was no significant difference between the condition of the gums in the two groups."

Numerous tests showed that plasma Ascorbic acid values were extremely low, even in apparently healthy individuals engaged in hard work. These low values were not

significantly /

significantly raised by the additional daily ration of Ascorbic acid. In 78 (47 healthy) the plasma values ranged from 0.10 mgm% to 0.30 mgm% and the lowest level for healthy gums was 0.12 mgm%. Data concerning over 1,000 cases of scurvy occurring in the Witwatersand gold mines over several recent years were also carefully examined from various angles. Among other conclusions these Authors mention that there was no evidence to suggest that natives engaged in the more strenuous types of work developed scurvy either more often or more quickly than those whose metabolic resources were less severely taxed. On reflection it is surmisable that this would be so for their intake was continuing at its accustomed level and this would normally be controlled by the amount of work they did.

These results are thus evidence against the association maintained in this thesis. In criticism it may however, be pointed out that Vit. C metabolism is probably very different in the native from what it is in the European. This is suggested by the figures given by the above Authors of the Vit. C content of fresh livers removed at post mortem.

European Livers = 25 cases. Mean value 320 mgm Ascorbic acid per liver.

Native Livers = 32 cases. Mean value 115 mgm Ascorbic acid per liver.

The evidence of these Authors is thus to be viewed with circumspection when considering the Vit. C metabolism of Europeans.

Francis (J.Amer. Dent. Assoc. 1941.28.1296.) in discussing /

discussing Vincent's infection comments on the danger of a generalised flare up of the disease owing to a repetition of the very conditions existent during the first world war in our present times. He believes that diet is intimately concerned with tissue resistance and that the endocrine glands must themselves be supplied with proper dietary nourishment to prevent disfunction, quoting the gingivitis of pregnancy as evidence of glandular upset. In treatment of the condition he emphasises the importance of normal dental hygiene, together with regular massage of the gingivae and "health building" in the form of an adequate dietary regime.

The argument may now be pursued from a different angle. Assuming on the basis of our own work and on the evidence quoted above, that there is a definite association between Infective Gingivitis and Vit. C subnutrition, it is then logical to claim that the presence of this type of Gingivitis is but an early manifestation of subclinical scurvy and that its presence of any significant scale in a community is an index of the state of nutrition of that community, with particular reference to Vit. C lack. If this be so, then it is possible that other symptoms of scurvy may manifest themselves singly as a precursory sign of the subclinical state. McCollum in "The Newer Knowledge of Nutrition" draws attention to the fact that in humans a deficiency of Ascorbic Acid scarcely ever occurs unaccompanied by other inadequacies or dietary imbalance and that these tend to produce variability in the symptoms referable to scurvy. Scurvy has in general the following characteristics; the adult loses weight, is anaemic /

anaemic, weak and breathless. The gums become swollen, bleed easily and frequently ulcerate. The teeth loosen and may drop out. Necrotic areas in the jaw bones may occur, haemorrhages into the mucous membranes, the muscles and the subcutaneous tissues are characteristic. Blue-black spots develop in the skin after trivial injury or they may occur spontaneously. The ankles become oedematous and in severe cases there develops a hard board-like condition of the skin and subcutaneous tissues. From this description it is seen that anaemia is one of the marked early signs of scurvy. The relationship of this anaemia specifically to ascorbic acid deficiency is discussed by Dunlop and Scarborough (Edin.Med.J.1935.42.476). They describe the treatment of two old batchelors living alone on a scorbutic diet,with frank scurvy and in one with alcoholic gastritis,together with bronchitis and emphysema. The anaemia cleared up remarkably on Vit. C therapy alone (60 mgm. / day by mouth). They showed a considerable reticulocytosis (15%) present in the deficient state without Vit. C together with haemoglobin of 48%, (b) a definite degree of reticulocytosis continued during the period under ascorbic acid therapy and a rapid increase in the red blood corpuscle count, (c) this improvement in red blood corpuscles and in haemoglobin continued after the cessation of Ascorbic acid therapy and continuance of the scorbutic diet - while the reticulocytosis fell to 0.4, thus pointing to the effect of Vit. C storage. These Authors conclude their article as follows:-

"If /

"If Vit. C has a specific effect on the anaemia of scurvy, distinct from its effect in controlling the haemorrhages, then it is possible that a deficiency of this substance may be an additional factor in producing anaemia in working class populations even in the absence of other signs and symptoms of frank scurvy."

Jennings and Glazebrook (B.M.J. 1938.2.784) compared the clinical and blood pictures in adult scurvy. They describe two cases both with anaemia, the first a megalocytic anaemia (originally diagnosed as pernicious anaemia) and the second an orthochromic normocytic anaemia. Both failed to respond to iron and liver therapy and responded to Vit. C therapy - their excretion rates being grossly abnormal and becoming normal under treatment. The association of Vit. C deficiency and bleeding gums was only noted in the second case, although both cases showed ecchymosis, particularly behind the knees. In the first case, they point out that the anaemia was much the earliest manifestation of the disease so that it is not surprising that it was the last to disappear. The history showed that Vit. C deficiency must have been present for many years before scurvy became clinically manifest.

Mettier, Minot and Townsend (J. Amer.Med.Assoc. 1930. 95.1089) state that in adults with scurvy the pronounced anaemia often encountered can be promptly relieved by providing foods rich in ascorbic acid. There is a marked reticulocytosis and rapid regeneration of the blood. Neither large doses of iron nor "the substance potent in pernicious anaemia" /

anaemia" appear to accomplish these effects in the scorbutic state.

King (Lancet 1941.II.293) comments on the successful treatment of three cases of acute ulcerative stomatitis by blood transfusion by Walton and associates (Lancet 1941.2. 214). The rationale of such therapy would appear to be the supplying of all the missing nutritional factors to the deficient patients. Attention is however, also drawn to treatment of Vincent's infection by nicotinic acid. King's opinion is summarised as follows:- "I believe that nutritional deficiency and traumatic injury of the gums are the main aetological factors in this disease. This belief is based on the treatment of 276 cases of ulcerative Gingivo-Stomatitis since June 1940. Eighty-one with nicotinic acid alone, 121 with nicotinic acid supplemented by local measures, 14 with Ascorbic acid (with little or no beneficial effect) and 60 by local treatment alone. Successful treatment to some extent depends on the type of case, acute, subacute or "flaring" subacute. The last two types often respond only slowly to nicotinic acid or local measures separately." This last remark would point to some underlying condition which is not being treated by this method and it would not be surprising to find that Vit. C deficiency was the answer.

A somewhat similar reference is to be found in "The Newer Knowledge of Nutrition" (p.189) pointing out the association of pellagra and Gingivitis.

"In /

"In pellagra, gingivitis, scarlet red stomatitis and glossitis are always present: they are usually early symptoms. The tip and margins of the tongue become very red and much swollen. Ulcers may form, covered with a grey membrane and over-run with the micro-organisms of Vincent. In fact, to the uninitiated the severe Vincent's infection may well mask the real complaint. Jolliffe states, "patients having the stomatitis of nicotinic acid deficiency are too frequently considered to have only the superimposed Vincent's infection."

The primary diagnosis is not considered and specific therapy is neglected. If nicotinic acid therapy is instituted, not only is the scarlet red stomatitis blanched within 24 - 48 hours, but the Vincent's infection heals without other general or local therapy.

Vit. C affects the endothelium of the capillaries and the intercellular cement substance. A lack of this vitamin causes the capillaries to become permeable and favours interstitial haemorrhages. This accounts for the swollen hemorrhagic gums of scurvy. Secondary infection, especially by the fuso-spirochetal complex, may result in a condition that masks the true mischief.

It must be borne in mind that an avitaminosis may not have a textbook appearance. Many of the cases are border-line cases. Empiric treatment of a secondary infection may have little lasting effect unless the underlying cause is found." The same work also lays considerable stress on the role of ascorbic acid in bodily processes (p.418).

It is stated that Ascorbic acid functioning is particularly concerned with cells of mesenchymal origin. The nutrient is necessary for the formation of all intercellular substances having collagen, or collagen-like substances as their basis. Thus the characteristic hemorrhages of scurvy are attributable to the inability of the body to produce intercellular material. The latter is necessary to prevent separation of the single layer of endothelial cells which form the walls of blood capillaries. It is the cementing substance which holds these cells together. This intercellular material constitutes the foundation of all fibrous structures, the matrices of bone, dentin, cartilage, and all non-epithelial cement substances,including that of the vascular endothelium.

The general concept of Ascorbic acid in relation to specific types of cells was reached through studies of human scurvy, which may have been accompanied by other dietary defects, and experimental scurvy in guinea pigs. The latter probably was unassociated with any other dietary defects.

As early as 1919 it was shown experimentally by Zilva and Wells that radical changes in tooth structure are associated with deficiency of the anti-scorbutic nutrient. Howe (1919) also investigated dental changes in this deficiency, being primarily concerned with studies of the cause of dental caries. However, it was the extensive and classic work of Höjer (1924 Acta. Pediat.Suppl. 3.8) which revealed in detail the pathological effects of ascorbic acid deficiency /

deficiency on the teeth. A summary of the changes he observed, stated in his own words, is as follows:-

" 1. The gradual change of the odontoblast layer. This seems to be a sure sign of scurvy and one of the earliest changes to set in. The odontoblasts assume another shape, grow shorter, more rounded, and show another arrangement, the normal regular, creeper-like formation makes way to a layer, which in some places curves in towards the centre of the pulp and is soon split through the cells secreting a hard tissue between themselves, so that the syncytical character of the cell layer does not plainly appear. The odontoblasts have been transformed into osteoblasts placed in bone canals.

2. The amorphous calcification of the predentine.

3. Widening of Tomes' canals in the dentine before the onset of scurvy.

4. New formation of bone instead of dentine. This bone is first lying as a thin layer inside the calcified predentine, but soon extends reticularly towards the centre of the pulp. This bone has a spongy, porous character.

5. Dilation of vessels and in early stages hyperemia; sometimes haemorrhages in the pulp.

6. Atrophy and resorption of pulp tissue, pulp cells, the newly formed bone and the old dentine. This resorption which, as everywhere in bone formation, will surely be found also with scurvy in all stages, appears more distinctly after all the new bone formation in the final stage has stopped, and may proceed so far, that in place of pulp tissue there is seen nothing but some large hollows filled with fluid.

7 In /

7. In the healing of the scurvy - at an earlier stage - reorganisation of the pulp bone into irregular dentine, osteo-dentine, with bone canals and dentinal canals.

8. In a scurvy which is latent all through or very much mitigated, when at least half the amount of anti-scorbutic needful to an individual is provided - forms which are the most common in man - the progress is similar although not so pronounced and presents pictures that differ considerably from the normal. If the anti-scorbutic dose provided is 0.5 - 0.7 of the minimum protective dose, an irregular dentine is formed within the Tomes' canals and in most symmetric places ridges of a hard tissue, with the character of bone and lacking dentinal canals. In this pulp bone as well as in the newly formed irregular dentine, there are canals of Havers' type and isolated bone corpuscles which may be considered to consist of transformed odontoblasts.

With an anti-scorbutic dose of 0.8 or more of the minimum protective dose, the picture here described is changed so far that there is no pulp bone but all the newly formed hard tissue in the pulp consists of osteodentine, or even dentine (the first formed layer)."

SUMMARY OF THE LITERATURE.

It is thus seen that much of the literature is in support of this thesis. Roff and Glazebrook (1940) demonstrated the therapeutic value of Vit.C in the Gingivitis of adolescents, basing their work on very similar findings of Kramer (1937) amongst German army personnel. Campbell & Cook (1941) applied a therapeutic test to 14 cases of Gingivitis and claimed that the previously sore and inflammed gums became normal after approximately 4 days treatment. On the basis of their bacteriological findings and the speed with which cure was attained it is thought that their cases were of the sub-acute variety and not the acute form dealt with in our own work. A confirmatory view is to be found in the work of Stammers (1942) and in that of Stuhl & Coventry (1942), the latter Authors laying stress on the value of a combination of the recognised local, parenteral and Vit. C therapy in these cases.

Additional evidence of the belief that Vit. C lack is a potent underlying factor in the causation of infective Gingivitis, is found in the text books of Cahn (1941) and of Mead (1940). The latter lays great stress on the investigation of the blood picture, of dietary deficiency generally and of the elimination of septic foci.

In the experimental field the work of Topping and Fraser (1939), repeated in greater detail by Chapman & Harris (1941), on monkeys led to the conclusion that fuso-spirochetosis requires an underlying,pre-disposing, sub-nutritional factor for /

factor for development and is thus not strictly contagious in the commonly accepted meaning of the term. Put in another way they concluded that monkeys maintained on certain vitamin deficient diets develop a tendency to oral lesions, accompanied by an increase in the fuso-spirochetal flora. Monkeys maintained on an adequate stock diet do not exhibit this tendency.

Hanke in a series of papers (1930 - 1934) contributes much supporting evidence and summarises his opinion as follows: "We are not of the opinion that any syndrome is specifically due to the direct lack of any one vitamin. Many factors are involved in the proper functioning of any body cell, and all of the body hormones and all of the vitamins are probably equally important in maintaining a cellular condition that is efficient." He also lays stress on the finding that the provision of a pint or more daily of orange juice to a diet otherwise nearly normal not only arrested caries but brought about a marked improvement in the health of the gingival tissues.

Very similar findings are reported by Cady (1937), working amongst the American Indians and by Goodrow (1936), in an epidemic of Vincent's Infection in the San Luis Valley of California. Crane & Woods (1941) in a survey of elementary school children in a Maine village showed that many of the children were undernourished with respect to Vitamin C and showed a high incidence of Gingivitis; this incidence was markedly /

markedly decreased by supplementing the normal diet with Vit. C.

Boyle, Bessey & Wolbach (1937) note that the histological appearances in cases of peri-odontal disease in man of the type known as diffuse alveolar bone atrophy are almost identical with those found in the peri-odontal tissues of guinea pigs suffering from scurvy. They suggest that insufficient intake of Vitamin C is an important factor in determining the onset of this variety of pyorrhoea and that the state of Vit. C subnutrition should be examined as a matter of routine before operative measures are taken to relieve it. Fitzsimmons (1941) endorses this opinion.

Much evidence in support of our thesis is summarised in "Mouth Infections and their Relation to Systemic Disease" by MacNevin & Vaughan (1933) and they refer to the evidence of Buchanan in India (1904), Marshall in Tristan da Cunha (1927), MacCollum in Australia (1929), Wilkinson in Australia (1929) and Leonard in America (1929).

Weisberger, Young and Morse (1938) contribute a study of the ascorbic acid blood levels in dental patients and although their general conclusions would appear to be in line with other work, are open to certain criticisms, chiefly due to their standards differing from those of others, causing their interpretations to be misleading.

The work of Höjer (1924) discusses in detail the pathological effects of ascorbic acid deficiency on the teeth; while the relationship of the anaemia of scurvy specifically to ascorbic acid deficiency is discussed by Dunlop and Scarborough /

Scarborough (1935) and by Jennings & Glazebrook (1938). Mettier, Minot & Townsend (1930) state that in adults with scurvy the pronounced anaemia often encountered can be promptly relieved by providing foods rich in ascorbic acid.

The opposing point of view, that Vincent's infection and Vit. C subnutrition are two independent, unrelated states is voiced in "Medical Notes in Parliament," (B.M.J. 1942.1. 242), where it is noted that the "official" view is that the evidence, that infective Gingivitis is due to dietary deficiencies, is considered to be "far from convincing". A similar opinion is stated by Pittenger and Roanohe (1930) who believe the condition to be wholly contagious.

Fox and his colleagues (1940), working amongst mine labourers in South Africa, and using blood plasma ascorbic acid determinations, are also against the association of Gingivitis and Vit. C subnutrition. Their article can, however, be criticised on the grounds that native Vit. C metabolism would appear to differ from that of Europeans and also that they place reliance on blood plasma estimations, which are known to bear but little relation to the urinary excretion findings.

King (1941) believes that nutritional deficiency and traumatic injury of the gums are the main aetological factors in this disease, but lays great stress on the value of Vit. B therapy and remarks that he has been able to demonstrate little or no beneficial effect with ascorbic acid therapy alone. Attention is also drawn to the work of /

of Walton and associates (1941) who successfully treated 3 cases of acute ulcerative stomatitis by blood transfusion only.

A similar reference is to be found in "The Newer Knowledge of Nutrition" - MacCollum (1939), pointing out the association of pellagra and gingivitis.

The bulk of the literature is thus in support of the theory that dietary deficiency is a potent predisposing element in the aetiology of infective gingivitis and that Vit. C lack, in particular, is one of the most important factors and should invariably be looked for prior to commencing local treatment. Our own findings are in agreement with this theory.

SUMMARY AND CONCLUSIONS:-

In Part I an account is given of an investigation conducted during the winter and spring of 1941-42, into the ascorbic acid excretion of 100 ratings, all more or less healthy, in an attempt to assess the degree of hypovitaminosis C present in this base. The urinary excretion method of assessment of Tillmans, as modified by Harris, was used throughout. It was found that 15% of the cases were "saturated", 60% were "Mildly unsaturated", while 25% showed a"more severe degree of unsaturation," and that among the unsaturated 27% only showed clinical signs of unsaturation. On an average it took 3 days to saturate the unsaturated. A slightly higher degree of unsaturation was found amongst the shore based personnel than that amongst the trawlermen living on board (95% compared with 85%). This was attributed (a) to the trawlermen being on the whole a fitter and younger section of the community, speaking generally, (b) to an increased dietary fastidiousness amongst those ashore and to the fact that, obtaining regular shore leave, they spent their earnings more on beer than on food, (c) to the disadvantages of large scale cooking ashore. It is considered that this high proportion of unsaturation amongst a so-called "fighting fit" section of the general populace is not satisfactory and by deduction the state of affairs amongst the civilian population must be less satisfactory still. This conclusion is supported by the findings of the other authors referred to in /

in the literature and who have demonstrated (a) a marked fall in the average daily content of Vitamin C in the average diet since the commencement of the war and (b) a fall to low unsaturation levels in the various sections of the community investigated. It is therefore thought that although, but few cases of clinical scurvy have been reported either in the armed forces or amongst the civilian population, the community as a whole is running on dangerously low levels and that any sudden worstening of the dietetic situation as might occur in (say) a state of siege could precipitate a wide outbreak of clinical scurvy, particularly amongst the industrial section of the population.

Various methods of combating this deficiency are suggested (a) by husbanding and increasing the various sources of Vit. C available in the country and spreading the consumption throughout the year so that the lean period in the winter and spring is satisfactorily covered and (b) by issuing synthetic ascorbic acid tablets daily in cases where the first method is insufficient. It is also pointed out that this latter step should not be pursued indiscriminately, but only in cases of necessity, as has already been done amongst large numbers of school children, during this war, in Germany, with marked benefit, during periods of the year when natural Vit. C containing foodstuffs are not available. The cost of production and the large quantities required however, make this method impracticable on a general scale.

An attempt was made to assess by capillary resistance tests the state of Vit. P nutrition in this community, but owing to failures in technique was not very satisfactory.

As /

As far as can be concluded from this limited work but little Vit. P deficiency was found to exist and no clinically defective cases have been noted.

In Part II an account is given of an investigation conducted during the spring and summer of 1942, using the same urinary excretion method of assessment, into the association of Vincent's Stomatitis and Vit. C subnutrition, since it had been observed that Vincent's Stomatitis occurs frequently amongst the personnel under our immediate care and that cases treated by local measures only, frequently recur.

It was demonstrated (Series 7) that Vincent's Stomatitis, diagnosed clinically and bacteriologically, does not clear up with normal dental hygiene and the general sick bay messing, but is in fact progressive.

Of 36 cases of Gingivitis investigated it was found that none of them were saturated with Vit. C, that 12% of them were "mildly unsaturated" using the same standards as in Part I, and that 88% were "more severely unsaturated." It was also found that on an average these cases took 5 days to saturate and that the clinically more severe cases took 6 days.

The application of a therapeutic test to 14 cases of Vincent's infection of the gums and buccal mucosa, diagnosed clinically and bacteriologically, showed that all the cases including the recurrent cases, could be cured by a combination of normal dental hygiene and massive dosing with ascorbic acid - 700 mgm. a day, till saturated and followed by a maintenance dose of 100 mgm. a day. On an average it took 14 days to cure - the healthy appearance of the gums and the absence of /

of the typical organisms being taken as the criterion of cure. It was also found that the severer the case the greater the degree of unsaturation that could be demonstrated and the longer the case took to cure. To date, as far as is known, none of the cases so treated have recurred. A few of the cases required mechanical dental treatment, chiefly scaling and syringing with hydrogen peroxide, to complete cure and two cases required one dose each of intravenous arsenicals to produce a negative gum smear. At the conclusion of their course all the cases showed a marked improvement in their general health, were of an outstandingly fresh and rubicund complexion and the majority of them commented on how unusually fit they felt.

These results can best be summarised as follows:-

Average No. days required to saturate (all cases)	5 days.
Average No. days required to cure clinically (all cases)	14 days.
Average No. days required to cure bacteriologically (all cases but one)	14 days.
No. of cases requiring further dental treatment of gums to cure.	5 cases.
Average No. days required to saturate clinically severe cases.	6 days.
Average No. days required to cure clinically severe cases.	16.8 days.
Range of No. days required to cure all cases.	4-31 days.
Recurrence rate (as far as is known)	Nil.
No. of cases previously treated by local measures and recurring were treated successfully by Ascorbic Acid.	5 cases.

It is thus to be noted that amongst the cases of Gingivitis none were found to be saturated compared with 15% of the healthy ratings: that there is an increase in the number of the more severely unsaturated cases amongst those with /

with Gingivitis than amongst the healthy ratings (88.8% compared with 25%) and that the Gingivitis cases took longer to saturate than the healthy ratings (5 - 6 days depending on the severity, compared with 3 days).

It is also notable that cases of Gingivitis can be cured by massive doses of Ascorbic acid together with normal dental hygiene.

These findings are thus suggestive of an association of Gingivitis with Vit. C submutrition. It is suggested that although local measures alone may produce an apparent cure, the high recurrence rate, together with the above findings point to Vit. C lack as being the chief underlying causative factor.

It is suggested also that the best method of therapy is first to saturate the case with Vit. C and then to apply local and parenteral measures, as were done in the cases in Series 7, cutting down the time required to cure to 7 - 10 days.

A summary and discussion of the relevant recent literature is entered into and much evidence is found in support of our thesis.

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TABULATED RESULTS.

SERIES 1.

100 Ratings on Full Duty.

ASCORBIC ACID EXCRETION RATES.

Abbreviations:-

T. = Trawlerman, Living on Board.
V.A. = Vincents Stomatitis.
P. = Pyorrhoea.
S.B. = Living in Sick Bay (Non-metabolic disorder).

All other Ratings are employed in the base and live in Camp.

NAME & REMARKS	Cap. Res.	MORNING Urine Vit. C. Content in mgm%	6 HOUR Urine Vit C. Content in mgm%	MORNING Urine Total Vit. C. Content	6 Hr. URINE Total Vit. Content.
ARRIS, H.W., Wtr.	0	80 cc. 2.0 mgm%	80 cc. 2.0 mgm%	1.60 mgm.	1.78 mgm.
AITCHISON, R., O/Sea T. (Primary Syphilis)		40 cc. 2.85 "	120 cc. 2.85 "	1.14 "	3.42 "
BOYDEN, L.F. S.B.A.	0	100 cc. 1.08 "	320 cc. 1.43 "	1.08 "	4.58 "
BRYAN, N.F.	0	40 cc. 1.67 "	440 cc. 0.75 "	0.87 "	3.21 "
BRIGGS, F.C., Stwd. (Spongy gums)	2	100 cc. 1.08 "	180 cc. 0.95 "	1.08 "	1.71 "
BERRY, K.B., Stwd.	6	40 cc. 2.0 "	120 cc. 1.33 "	0.8 "	1.60 "
BLAND, H., O/Sea. (V.A.), T., S.B.	0	80 cc. 1.82 "	200 cc. 2.22 "	1.47 "	4.44 "
BLACKEY, T., A.B. T. (Chronic Catarrh) S.B.	46	120 cc. 1.33 "	100 cc. 1.33 "	1.60 "	1.33 "
BENNETT, J., Sea. T. (Scabies) S.B.	0	40 cc. 2.11 "	180 cc. 4.0 "	0.84 "	7.20 "
BURNETT, M., O/Sea. T. (V.A.)		100 cc. 1.33 "	40 cc. 2.35 "	1.33 "	0.94 "

BUCHANAN,J.W. Surg.Lieut.	0	600 cc. 1.17 mgm%	440 cc. 1.17 mgm%	7.02 mgm.	5.59 mgm.
BUSBY,C.,Stwd. (Gums slight bleeding)	0	160 cc. 0.61 "	180 cc. 1.60 "	0.98 "	2.88 "
BATES,P.D.,A/Stwd.3 (Gums bleed on cleaning)		10 cc. 0.77 "	260 cc. 1.48 "	0.08 "	3.85 "
BUCHAN,E.,Sea. (S.B.) Furuncul-:osis(Received A.A. daily for 14 days)hence not counted as a case.		360 cc. 3.33 "	220 cc. 8.00 "	11.99 "	17.60 "
BEARD,W.A., Sig. (Primary Syphilis)		100 cc. 2.22 "	180 cc. 3.07 "	2.22 "	5.33 "
CHAPMAN, A.,Sto.	7	30 cc. 1.60 "	140 cc. 2.00 "	0.48 "	2.8 "
CALWELL,A.E. L/Sea., S.B., (Chronic Bronchitis)	0	110 cc. 1.78 "	420 cc. 1.33 "	1.96 "	5.59 "
COCKERILL,B.N. S.B.A.	0	60 cc. 1.33 "	200 cc. 3.08 "	0.80 "	6.16 "
CHADWICK,J. L.S.B.A.	1	200 cc. 2.11 "	180 cc. 3.33 "	4.22 "	5.99 "
CUNDLE,A.F. Sto.	12	200 cc. 1.60 "	100 cc. 1.18 "	3.20 "	1.18 "
CALDICOTT,C.V. Sto.	0	180 cc. 1.48 "	140 cc. 2.00 "	2.66 "	2.80 "
CATLIN,T.J.,O/Sea. (S.B.) Fract. Metatarsal.	2	320 cc. 2.35 "	180 cc. 2.22 "	7.52 "	4.00 "
CONWAY,J. S.B.(Multiple Furunculosis & Scabies)	1	360 cc. 1.77 "	140 cc. 1.82 "	6.38 "	2.55 "
COOK,J. Sea.	2	20 cc. 1.25 "	80 cc. 2.00 "	0.25 "	1.60 "
CLARKE,F. Sea.	0	60 cc. 2.50 "	60 cc. 1.38 "	1.50 "	0.83 "
CROMBIE,H. Sea. (Spongy Gums)	5	80 cc. 2.0 "	80 cc. 2.0 "	1.60 "	1.60 "

COOLIGAN, L., O/Sea. (Recurrent Tonsillitis)		100 cc. 0.85 mgm%	80 cc. 0.80 mgm%	0.85 mgm.	0.64 mgm.
CHAPMAN, R., Jnr. (Primary Syphilis)		40 cc. 2.35 "	160 cc. 2.00 "	0.94 "	3.20 "
DAVY, C.H., Wtr. (Bleeding Gums)	0	200 cc. 1.74 "	60 cc. 1.91 "	3.48 "	1.15 "
DOWNTON, G., L/Stwd. (Spongy Gums & Common Cold)	8	30 cc. 1.33 "	200 cc. 3.33 "	0.40 "	6.66 "
DICKSON, G., O/Sea. (V.A.)		260 cc. 0.89 "	110 cc. 1.60 "	2.31 "	1.76 "
EVANS, W.S., Sea.	0	40 cc. 1.82 "	220 cc. 4.0 "	0.65 "	8.80 "
EDWARDS, J., O/Sea. T. (S.B.) Scald Foot.	1	560 cc. 1.18 "	80 cc. 5.00 "	6.61 "	4.00 "
FLETCHER, S., L/Sto. T. (Gums bleed on cleaning).	0	50 cc. 1.67 "	200 cc. 2.67 "	0.84 "	5.34 "
FERRIS, J.W. L.S.A.	0	200 cc. 1.33 "	180 cc. 2.11 "	2.66 "	3.80 "
FOWLER, H.J., A.B. (Recurrent V.A.)		480 cc. 0.58 "	320 cc. 0.29 "	2.78 "	0.93 "
GIBSON, S.	1	100 cc. 1.78 "	280 cc. 1.25 "	1.78 "	3.50 "
GALLACHER, F., A.B.	0	200 cc. 1.37 "	280 cc. 1.38 "	2.74 "	3.86 "
GEORGE, E.T., Sea. (Bleeding gums)	4	30 cc. 1.08 "	120 cc. 4.0 "	0.32 "	4.80 "
GRUAR, N., A/Stwd.	7	40 cc. 2.11 "	80 cc. 2.11 "	0.84 "	1.67 "
GODFREE, F. L/Writer	4	100 cc. 1.82 "	100 cc. 2.00 "	1.82 "	2.00 "
GUNN, T., Sea. (S.B.) Pyorrhoea & Spongy Gums.	0	140 cc. 2.35 "	340 cc. 1.90 "	3.29 "	6.46 "
GRUBB, J., Sea. Spongy Gums.	2	20 cc. 2.0 "	160 cc. 2.50 "	0.4 "	4.00 "
GLEN, W.G. Stoker	0	100 cc. 0.34 "	120 cc. 1.67 "	0.34 "	2.00 "

GOODALL,P.C.,P.O. T.(Secondary Syphilis)		160 cc. 0.73 mgm%	140 cc. 1.60 mgm%	1.17 mgm.	2.24 mgm.
GREEDY, S. Stwd.	2	40 cc. 2.35 "	60 cc. 5.71 "	0.94 "	3.43 "
HAYCOCK,G. L/Sto.	5	100 cc. 0.64 "	340 cc. 0.93 "	0.64 "	2.26 "
HAMILTON,W.S. A.B.	18	100 cc. 1.67 "	210 cc. 2.35 "	1.67 "	4.95 "
HUMBERSTONE,H. Writer	1	280 cc. 1.90 "	300 cc. 0.89 "	5.32 "	2.67 "
HOLMES,S.W. S.A.	2	20 cc. 0.91 "	200 cc. 2.11 "	0.18 "	4.22 "
HENDERSON,J.P. Off./Stwd.	0	20 cc. 2.35 "	80 cc. 6.67 "	0.47 "	5.78 "
HARPER,J., O/Sea. T.	1	460 cc. 1.43 "	320 cc. 1.60 "	6.58 "	5.12 "
HADDOCK,T.,L/Ck. (V.A.) T.	0	40 cc. 1.00 "	240 cc. 1.14 "	0.40 "	2.74 "
HILLHOUSE, Cook (V.A.) T.	5	100 cc. 4.0 "	220 cc. 4.0 "	4.0 "	8.80 "
HISCOCK,S.,O/Sea. (V.A.) T.		140 cc. 1.60 "	120 cc. 13.33 "	2.24 "	16.0 "
HALL,Henry, A.B. (V.A.)		360 cc. 0.8 "	600 cc. 0.72 "	2.88 "	4.32 "
HENDERSON, O/Sea. (V.A.)		360 cc. 1.82 "	160 cc. 1.08 "	6.55 "	1.73 "
HEWETT,S.,Stoker T. (Primary Syphilis)		300 cc. 1.50 "	260 cc. 1.53 "	4.50 "	3.98 "
JACKSON,J., Cook T.	1	100 cc. 0.62 "	200 cc. 1.82 "	0.62 "	2.64 "
JOHNSTONE,G. A.B.	7	40 cc. 1.82 "	340 cc. 0.45 "	0.73 "	1.53 "
JOHN,W.J.,O/Sea. T.(S.B.) Furunc-:ulosis.	0	30 cc. 1.64 "	200 cc. 2.60 "	1.09 "	3.20 "
JACKSON,G.,O/Sea. (V.A.) T.		340 cc. 2.50 "	40 cc. 2.85 "	8.50 "	1.14 "
KING,A., Sea. (V.A.)		220 cc. 2.85 "	300 cc. 1.18 "	6.27 "	3.54 "

LOWERSON,W.,C/K. (V.A.),S.B. T.	5	50 cc. 6.67 mgm%	260 cc. 1.74 mgm%	3.34 mgm.	3.52 mgm.
LARKIN,G.F., Tel. (V.A.) T.	20	110 cc. 1.82 "	240 cc. 1.82 "	2.00 "	4.37 "
MURRAY,D., Sea. (Spongy Gums)	7	80 cc. 1.51 "	560 cc. 0.89 "	1.11 "	4.98 "
MORGAN,D. S.A.	1	310 cc. 1.70 "	200 cc. 2.50 "	5.27 "	5.00 "
MORRIS,J.,A/Ck. (Mild Pyorrhoea)	0	40 cc. 1.25 "	180 cc. 1.83 "	0.50 "	3.29 "
MARTIN,C.F.,Wtr. P.O.	0	100 cc. 1.03 "	110 cc. 2.22 "	1.03 "	2.44 "
MARLAW,E.G.,O/Sea. S.B.,(Scabies)	3	60 cc. 3.64 "	100 cc. 5.71 "	2.18 "	5.71 "
MUIR,A., A.B. T. (Spongy Gums)	0	120 cc. 2.50 "	500 cc. 0.59 "	3.05 "	2.95 "
MARSHALL,C.,O/Sea. T. (Primary Syphilis)		500 cc. 0.87 "	200 cc. 2.50 "	4.35 "	5.00 "
MILLAR,H., C.P.O. T. (Primary Syphilis)		60 cc. 1.14 "	300 cc. 1.21 "	0.68 "	3.63 "
MACNIVEN,G.,Wtr.	5	200 cc. 0.95 "	80 cc. 0.33 "	1.90 "	0.26 "
McGLOIN,J.	0	100 cc. 2.67 "	110 cc. 1.18 "	2.67 "	1.30 "
McMONAGLE,P.,Sto. T. (Septic Ulcers Legs)		500 cc. 1.33 "	240 cc. 2.00 "	6.65 "	4.80 "
McQUIRE,J.,Sto. S.B.(Dental Abscess)	0	100 cc. 2.35 "	180 cc. 6.67 "	2.35 "	12.67 "
McMAHON,T.S.,O/Sea. (V.A.)		100 cc. 0.44 "	360 cc. 0.65 "	0.44 "	2.34 "
MACLEOD,M., Sea. (Primary Syphilis)		220 cc. 1.40 "	200 cc. 1.68 "	3.08 "	3.36 "
NAISH,J.M. Surg.Lieut.R.N.V.R.		100 cc. 0.26 "	240 cc. 1.14 "	0.26 "	2.74 "
OATEY,W.A.,L/Wtr.	0	100 cc. 2.0 "	80 cc. 2.67 "	2.0 "	2.14 "

PATTERSON,J. O/Stwd.	3	120 cc. 0.86 mgm%	340 cc. 1.43 mgm%	1.03 mgm.	4.86 mgm.
PEART,W.H.,Cook T.	5	30 cc. 0.59 "	210 cc. 4.54 "	0.18 "	9.53 "
PETHERIDGE,L.T. Chief Eng., (Furunculosis)		140 cc. 1.60 "	40 cc. 2.67 "	2.24 "	1.07 "
PAYNE,W.J., Sto. (Secondary Syphilis)		550 cc. 1.33 "	340 cc. 1.21 "	7.32 "	4.11 "
REGAN, F. A/Stwd.	2	60 cc. 1.43 "	100 cc. 3.23 "	0.86 "	3.23 "
ROBERTSON,J. Stoker	0	60 cc. 1.21 "	120 cc. 2.0 "	0.73 "	2.40 "
RILEY,J.W.,L/Wtr.	5	200 cc. 1.91 "	300 cc. 0.70 "	3.82 "	2.10 "
ROGERS,D.,C.P.O. (S.B.) Scabies.	4	30 cc. 2.22 "	110 cc. 2.00 "	0.67 "	4.20 "
STRANGE,R.C. A/Stwd.	12	30 cc. 3.08 "	100 cc. 10.0 "	0.92 "	10.00 "
STOTT,E., A/Stwd.	3	80 cc. 1.90 "	80 cc. 1.82 "	1.42 "	1.47 "
SIMPSON, T.,Stoker	1	360 cc. 1.90 "	120 cc. 40.0 "	6.84 "	48.0 "
THOMAS,A.W. Sto.II.	3	20 cc. 1.67 "	150 cc. 2.50 "	0.23 "	3.75 "
TRILLO,A.F. Sto. T.	0	20 cc. 0.62 "	140 cc. 1.50 "	1.24 "	2.10 "
TYLER,A.G.,C.P.O. (Tertiary Syphilis)		550 cc. 0.50 "	320 cc. 0.53 "	2.75 "	1.70 "
WALKER,H.A.,Sea. T. (S.B.) Crushed Foot.	1	30 cc. 1.7 "	580 cc. 1.05 "	0.52 "	6.09 "
WHITTNEY,H.O.,O/Sea T.	1	60 cc. 1.82 "	120 cc. 1.08 "	1.09 "	1.30 "
WIFFEN,A.,O/Tel. T. (S.B.)		340 cc. 2.0 "	200 cc. 1.82 "	6.80 "	3.64 "
WREN,J.,A.B. (Spongy gums, Bronchial Catarrh)	0	110 cc. 2.11 "	110 cc. 2.43 "	2.32 "	2.67 "
WILLS,D.H. Writer	0	60 cc. 1.7 "	60 cc. 1.33 "	1.02 "	0.80 "

WILLIAMS, G.S.	440 cc.	60 cc.		
Sig., (T)	0.91 mgm%	3.08 mgm%	4.00 mgm.	1.85 mgm.
(Primary Syphilis)				

SERIES 2.

ASCORBIC ACID EXCRETION

SATURATION TESTS.

5 Cases from the Sick Bay suffering from non-metabolic disorders.

Ratings in this Series were given 700 mgm.A.A. daily.

The overnight specimen and the 6 hour specimen were estimated daily. The 3 hour specimen was discarded.

NAME & REMARKS			Vol. of Urine passed.	Content of Vit.C. in mgm%	Total Content of Vit. C. in mgm.
SIMPSON,T. P.O.,Sto., Trawlerman, (scald of foot)	24.11.41	700 mgm.A.A.daily	360 cc.	1.90mgm%	6.84mgm.
			120 cc.	40.0 "	48.0 "
	25.11.41	" " " "	440 cc.	2.6 "	11.44 "
			440 cc.	50.0 "	22.0 "
	26.11.41	" " " "	300 cc.	10.0 "	30.0 "
			200 cc.	40.0 "	80.0 "
	27.11.41	" " " "	460 cc.	10.0 "	46.0 "
			240 cc.	80.0 "	192 "

Saturated from start.

NAME & REMARKS			Vol. of Urine passed.	Content of Vit. C. in mgm%	Total Content of Vit. C. in mgm.
EDWARDS,T. Engine-man	24.11.41	700 mgm. A.A. daily	560 cc.	1.18mgm%	6.61mgm.
			80 cc.	5.00 "	4.00"
Trawler-man, (Scald of Foot)	25.11.41	" " " "	240 cc.	1.17 "	2.81"
			30 cc.	3.33 "	0.99"
	26.11.41	" " " "	560 cc.	2.50 "	14.0 "
			400 cc.	4.00 "	16.00"
	27.11.41	" " " "	420 cc.	2.00 "	8.40"
			320 cc.	20.00 "	64.0 "
	Saturated on 4th day.				
HARPER,T. Sto. Trawler-man (Gonorrhoea)	24.11.41	700 mgm. A.A. daily	460 cc.	1.43mgm%	6.58mgm.
			320 cc.	1.60 "	5.12 "
	25.11.41	" " " "	600 cc.	1.67 "	10.02 "
			40 cc.	5.71 "	2.28 "
	26.11.41	" " " "	540 cc.	2.60 "	8.1 "
			500 cc.	10.00 "	50.0 "
	27.11.41	" " " "	520 cc.	2.86 "	14.87 "
			280 cc.	40.0 "	112.0 "
	Saturated on 3rd day.				
CATLIN,T. O/Sea. Trawler-man. (Fract. metatarsal L.foot)	20.11.41	700 mgm. A.A. daily	320 cc.	2.35mgm%	7.52mgm.
			180 cc.	2.22 "	4.00 "
	24.11.41	" " " "			
	25.11.41	" " " "	500 cc.	1.67 "	8.35 "
			400 cc.	3.23 "	13.32 "
	26.11.41	" " " "	600 cc.	3.33 "	19.99 "
			30 cc.	80.0 "	24.00 "
	27.11.41	" " " "	280 cc.	5.0 "	12.5 "
			210 cc.	80.0 "	168.0 "
	Saturated on 2nd day.				

NAME & REMARKS			Vol. of Ur-:ine passed	Content of Vit. C. in mgm%	Total Content of Vit. C.in mgm.
HILLHOUSE,S. Cook Trawler-:man (Scald of Arm)	17.11.41	700 mgm. A.A. daily	100 cc.	4.0mgm%	4.0mgm.
			220 cc.	4.0 "	8.80"
	24.11.41	" " " "			
	25.11.41	" " " "	400 cc.	1.33"	5.32"
			60 cc.	2.67"	1.60"
	26.11.41	" " " "	300 cc.	3.33"	9.99"
			80 cc.	26.67"	21.35"
	27.11.41	" " " "	500 cc.	2.11"	10.55"
			310 cc.	40.0 "	124.0 "
	Saturated on 3rd day.				

A N A L Y S I S.

Ascorbic Acid.

No. cases saturated from start = 1

No. cases saturated from 2nd day = 1

No. cases saturated from 3rd day = 2

No. cases saturated from 4th day = 1

5

Average number of days required to saturate = 3 days.

SERIES 3.

ASCORBIC ACID EXCRETION

S A T U R A T I O N T E S T S.

10 Cases of healthy Ratings on full duty.

Ratings in this Series were all given 700 mgm. of Ascorbic Acid daily from 24.11.41 and the overnight specimen estimated except where indicated.

NAME & REMARKS			Vol. of Urine passed.	Content of Vit.C. in mgm%.	Total Content of Vit.C. in mgm.
HADDOCK L/Ck.	17.11.41	Overnight Spec.	40 cc.	1.00mgm%	0.40mgm.
		6 Hr. Spec.	240 cc.	1.14 "	2.74 "
	24.11.41	700 mgm. A.A. daily Overnight Spec.	220 cc.	1.17 "	2.57 "
	25.11.41	Overnight Spec.	520 cc.	0.62 "	3.22 "
	26.11.41	Overnight Spec.	240 cc.	1.67 "	3.89 "
	27.11.41	Overnight Spec.	420 cc.	2.22 "	9.32 "
		6 Hr. Spec.	330 cc.	20.0 "	66.0 "
	28.11.41	Overnight Spec.	440 cc.	2.60 "	11.44 "
		6 Hr. Spec.	140 cc.	40.0 "	56.0 "
		Saturated on 3rd day.			
GLEN Sto.	19.11.41	Overnight Spec.	100 cc.	0.34mgm%	0.34mgm.
		6 Hr. Spec.	120 cc.	1.67 "	2.00 "
	24.11.41	700 mgm. A.A. daily Overnight Spec.	100 cc.	2.67 "	2.67 "
	25.11.41	Overnight Spec.	120 cc.	1.95 "	2.28 "
	26.11.41	Overnight Spec.	340 cc.	1.90 "	6.56 "
	27.11.41	Overnight Spec.	100 cc.	2.50 "	2.50 "
		6 Hr. Spec.	300 cc.	8.00 "	24.00 "
	28.11.41	Overnight Spec.	20 cc.	6.67 "	13.34 "
		6 Hr. Spec.	140 cc.	80.0 "	112.0 "
		Saturated on 4th day.			

NAME & REMARKS			Vol. of Urine passed.	Content of Vit. C. in mgm%	Total Content of Vit.C. in mgm.
CUNDLE Sto.	5.11.41	Overnight Spec.	200 cc.	1.60mgm%	3.20mgm.
		6 Hr. Spec.	100 cc.	1.18 "	1.18 "
	24.11.41	700 mgm.A.A.daily			
		Overnight Spec.	60 cc.	2.22 "	1.53 "
	25.11.41	Overnight Spec.	160 cc.	1.0 "	1.60 "
	26.11.41	Overnight Spec.			
	27.11.41	Overnight Spec.	60 cc.	2.35 "	1.41 "
		6 Hr. Spec.	100 cc.	10.0 "	10.0 "
	28.11.41	Overnight Spec.	440 cc.	1.60 "	7.04 "
		6 Hr. Spec.	300 cc.	8.0 "	24.0 "
		Saturated on 3rd day.			
BERRY A/Stwd.	31.10.41	Overnight Spec.	40 cc.	2.0 mgm%	0.8 mgm.
		6 Hr. Spec.	120 cc.	1.33 "	1.60 "
	24.11.41	700 mgm.A.A. daily			
		Overnight Spec.	60 cc.	1.0 "	0.60 "
	25.11.41	Overnight Spec.	320 cc.	1.73 "	5.54 "
	26.11.41	Overnight Spec.	360 cc.	2.22 "	7.99 "
	27.11.41	Overnight Spec.	340 cc.	2.50 "	8.50 "
		6 Hr. Spec.	100 cc.	6.67 "	6.67 "
	28.11.41	Overnight Spec.	400 cc.	3.08 "	12.32 "
		6 Hr.Spec.	280 cc.	20.0 "	56.0 "
		Saturated on 4th day.			
MARTIN P.O.	13.11.41	Overnight Spec.	100 cc.	1.03mgm%	1.03mgm.
		6 Hr. Spec.	110 cc.	2.22 "	2.44 "
	24.11.41	700 mgm. Ascorbic Acid daily.			
		Overnight Spec.	160 cc.	1.48 "	2.37 "
	25.11.41	Overnight Spec.	140 cc.	1.67 "	2.84 "
	26.11.41	Overnight Spec.	220 cc.	3.53 "	7.33 "
	27.11.41	Overnight Spec.	160 cc.	3.33 "	5.33 "
		6 Hr. Spec.	80 cc.	5.00 "	4.00 "
	28.11.41	Overnight Spec.	220 cc.	3.33 "	7.33 "
		6 Hr. Spec.	300 cc.	20.0 "	60.0 "
		Saturated on 4th day but almost certainly on 3rd.			

NAME & REMARKS			Vol. of Urine passed.	Content of Vit.C. in mgm%	Total Content of Vit.C. in mgm.
DAVY L/Wtr.	13.11.41	Overnight Spec.	200 cc.	1.74mgm%	3.48mgm.
		6 Hr. Spec.	60 cc.	1.91 "	1.15 "
	24.11.41	700 mgm.A.A.daily Overnight Spec.	80 cc.	1.23 "	1.08 "
	25.11.41	Overnight Spec.	320 cc.	1.60 "	5.12 "
	26.11.41	Overnight Spec.	560 cc.	2.60 "	14.56 "
	27.11.41	Overnight Spec.	160 cc.	3.35 "	5.33 "
		6 Hr. Spec.	200 cc.	40.0 "	80.0 "
	28.11.41	Overnight Spec.	240 cc.	5.71 "	13.70 "
		6 Hr. Spec.	260 cc.	26.67 "	69.34 "
		Saturated on 4th day but almost certainly on 3rd.			
HUMBERSTON L/Wtr.	30.10.41	Overnight Spec.	280 cc.	1.90mgm%	5.52mgm.
		6 Hr.Spec.	300 cc.	0.89 "	2.67 "
	24.11.41	700 mgm.A.A.daily. Overnight Spec.	60 cc.	1.67 "	1.00 "
	25.11.41	Overnight Spec.	200 cc.	1.78 "	3.46 "
	26.11.41	Overnight Spec.	240 cc.	3.33 "	7.99 "
	27.11.41	Overnight Spec.	140 cc.	5.00 "	7.00 "
		6 Hr. Spec.	260 cc.	40.0 "	104.0 "
	28.11.41	Overnight Spec.	30 cc.	5.0 "	1.5 "
		6 Hr. Spec.	260 cc.	40.0 "	104.0 "
		Saturated on 4th day but almost certainly on 3rd.			
GRUBB Sea.	17.11.41	Overnight Spec.	20 cc.	2.0 mgm%	0.40mgm.
		6 Hrs.Spec.	160 cc.	2.50 "	4.00 "
	24.11.41	Overnight Spec. 700 mgm.A.A. given daily.	220 cc.	0.67 "	1.47 "
	25.11.41	Overnight Spec.	240 cc.	2.0 "	4.80 "
	26.11.41	Overnight Spec.	280 cc.	1.33 "	3.72 "
	27.11.41	Overnight Spec.	400 cc.	3.35 "	13.32 "
		6 Hr.Spec.	180 cc.	40.0 "	72.0 "
	28.11.41	Overnight Spec.	180 cc.	2.86 "	5.15 "
		6 Hr.Spec.	280 cc.	40.0 "	112.0 "
		Saturated on 4th day ? and also on 3rd.			

NAME & REMARKS		Vol. of Urine passed.	Content of Vit.C. in mgm%	Total Content of Vit.C. in mgm.
McGLOIN Boy	5.11.41 Overnight Spec.	100 cc.	2.67mgm%	2.67mgm.
	6 Hr. Spec.	110 cc.	1.17 "	1.30 "
Seaman	24.11.41 Overnight Spec.	700 mgm. A.A. given daily.		
		100 cc.	1.54 "	1.54 "
	25.11.41 Overnight Spec.	260 cc.	1.23 "	3.20 "
	26.11.41 Overnight Spec.	80 cc.	1.67 "	1.34 "
	27.11.41 Overnight Spec.	260 cc.	2.00 "	5.40 "
	6 Hr. Spec.	80 cc.	20.0 "	16.0 "
	28.11.41 Overnight Spec.	280 cc.	4.44 "	12.43 "
	6 Hr. Spec.	260 cc.	80.00 "	128.0 "
	Saturated by 4th day.			
FERRIS L.S.A.	24.10.41 Overnight Spec.	200 cc.	1.33mgm%	2.66mgm.
	6 Hr. Spec.	180 cc.	2.11 "	3.80 "
	24.11.41 700 mgm. Ascorbic Acid given daily.			
	Overnight Spec.	240 cc.	1.67 "	4.01 "
	25.11.41 Overnight Spec.	200 cc.	1.60 "	3.20 "
	26.11.41 Overnight Spec.	280 cc.	1.05 "	2.94 "
	27.11.41 Overnight Spec.	340 cc.	2.35 "	7.99 "
	6 Hr. Spec.	300 cc.	20.0 "	60.0 "
	28.11.41 Overnight Spec.	60 cc.	2.50 "	1.50 "
	6 Hr. Spec.	40 cc.	160.0 "	64.0 "
	Saturated by 4th day.			

ANALYSIS:

4 Saturated by 3rd day.
6 Saturated by 4th day (2 of these possibly by 3rd)

Average number of days required to saturate = 3.50 days.

i.e. this agrees with the findings in Series 2.

SERIES 4.

ASCORBIC ACID SATURATION AND GINGIVITIS

36 Cases.

Name:	Morning Urine Vit. C. Content in mgm%.	6 Hour Urine Vit. C. Content in mgm%.	Morning Urine Total Vit C. Content.	6 Hr. Urine Vit. C. Content.	REMARKS.
BLAND, H. O/Sea.	80 cc. 1.82mgm%	200 cc. 2.22mgm%	1.47mgm.	4.44mgm.	Vincent's Stomatitis.
LOWERSON, W. Cook.	50 cc. ? 6.67 "	260 cc. 1.74 "	3.34 "	3.52 "	" "
LARKIN, G. Tel.	110 cc. 1.82 "	240 cc. 1.82 "	2.00 "	4.37 "	" "
HADDOCK, T. L/Ck.	40 cc. 1.00 "	240 cc. 1.14 "	0.40 "	2.74 "	" "
HILLHOUSE, J. Cook	20 cc. 1.25 "	80 cc. 2.00 "	0.25 "	1.60 "	" "
BURNETT, M. O/Sea.	100 cc. 1.33 "	40 cc. 2.35 "	1.33 "	0.94 "	" "
DICKSON, G. O/Sea.	260 cc. 0.89 "	110 cc. 1.60 "	2.31 "	1.76 "	" "
FOWLER, H. O/Sea.	480 cc. 0.58 "	320 cc. 0.29 "	2.78 "	0.93 "	" "
HISCOCK, S. O/Sea.	140 cc. 1.60 "	120 cc. 2.0 "	2.24 "	2.40 "	" "
HALL, H. A.B.	360 cc. 0.8 "	600 cc. 0.72 "	2.88 "	4.32 "	" "
HENDERSON, J. O/Sea.	360 cc. 1.82 "	160 cc. 1.08 "	6.55 "	1.73 "	" "
JACKSON, G. O/Sea.	340 cc. 2.50 "	40 cc. 2.85 "	8.50 "	1.14 "	" "
KING, A.E. Sea.	220 cc. 2.85 "	300 cc. 1.18 "	6.27 "	3.54 "	" "
McMAHON, T. O/Sea.	100 cc. 0.44 "	360 cc. 0.65 "	0.44 "	2.34 "	" "
PETHERIDGE, L., C/Eng.	140 cc. 1.60 "	40 cc. 2.67 "	2.24 "	1.07 "	" "

Name:	Morning Urine Vit. C. Content in mgm%	6 Hour Urine Vit. C. Content in mgm%	Morning Urine Total Vit. C. Content.	6 Hr. Urine Vit C. Content.	REMARKS.
BRIGGS,F. Stwd.	100 cc. 1.08mgm%	180 cc. 0.95mgm%	1.08mgm.	1.71mgm.	Spongy gums, bleeding on pressure.
DAVY,C.H. L/Wtr.	200 cc. 1.33 "	180 cc. 2.11 "	2.66 "	3.80 "	Occasional bleeding gums.
GEORGE,E.T. Sea.	30 cc. 1.08 "	120 cc. 4.0 "	0.32 "	4.80 "	Pyorrhoea, gums bleed on pressure.
JOHNSTONE,G. A.B.	40 cc. 1.82 "	340 cc. 0.45 "	0.73 "	1.53 "	Mild pyorrhoea.
MURRAY,D. Sea.	80 cc. 1.51 "	560 cc. 0.89 "	1.11 "	4.98 "	Spongy gums, bleeding on pressure.
MORRIS,J. A/Cook	40 cc. 1.25 "	180 cc. 1.83 "	0.50 "	3.29 "	Mild pyorrhoea.
WREN,J. A.B.	110 cc. 2.11 "	110 cc. 2.43 "	2.32 "	2.67 "	Spongy gums, bleeding on pressure.
MUIR,A. A.B.	120 cc. 2.50 "	500 cc. 0.59 "	3.05 "	2.95 "	Spongy gums, bleeding on pressure.
FLETCHER,S. L/Sto.	50 cc. 1.67 "	200 cc. 2.67 "	0.84 "	5.34 "	Gums bleed on pressure.
BUSBY,C. Stwd.	160 cc. 0.61 "	180 cc. 1.60 "	0.98 "	2.88 "	Gums bleed on cleaning.
GRUBB,J. Sea.	20 cc. 2.0 "	160 cc. 2.50 "	0.4 "	4.00 "	Spongy gums, bleeding on pressure.
CROMBIE,H. Sea.	80 cc. 2.0 "	80 cc. 2.0 "	1.60 "	1.60 "	Spongy gums, bleeding on pressure.
BATES,P.D. A/Stwd.	10 cc. 0.77 "	260 cc. 1.48 "	0.08 "	3.85 "	Gums bleed on cleaning.
DOWNTON,G. L/Stwd.	30 cc. 1.33 "	200 cc. 3.33 "	0.40 "	6.66 "	Spongy gums, bleeding on pressure.
GUNN,T. Sea.	140 cc. 2.35 "	340 cc. 1.90 "	3.29 "	6.46 "	Pyorrhoea, spongy gums.

Name:	Morning Urine Vit. C. Content in mgm%	6 Hour Urine Vit. C. Content in mgm%	Morning Urine Total Vit. C. Content	6 Hr. Urine Vit C. Content.	REMARKS.
JARDINE, L. O/Sea.	300 cc. 0.89mgm%	180 cc. 1.33mgm%	2.67mgm.	2.39mgm.	Vincent's Stomatitis (recurrent)
McELROY, W. O/Sea.	460 cc. 1.08 "	300 cc. 1.48 "	4.97 "	4.44 "	Vincent's Stomatitis.
BROGEN, M. Sto.	400 cc. 2.11 "	800 cc. 1.25 "	8.44 "	3.75 "	" "
NORTHROP, A. O/Sea.	400 cc. 1.33 "	200 cc. 1.60 "	5.32 "	3.20 "	Vincent's Stomatitis (recurrent)
HYETT, C. A.B.	400 cc. 1.33 "	140 cc. 2.67 "	5.32 "	4.74 "	Vincent's Stomatitis
BOXALL, J. O/Sea.	440 cc. 1.33 "	240 cc. 1.18 "	5.85 "	2.85 "	Vincent's Stomatitis.

SERIES 5.

CASE HISTORIES OF 14 RATINGS ALL SUFFERING FROM VINCENTS STOMATITIS and treated with 700 mgm. ASCORBIC ACID daily and normal dental hygiene.

1.

DICKSON, George, O/Sea., age 34, Trainee, Admitted 20.1.42.

Bleeding and painful gums - 3 days.
Gum Smear:- Vincents Organisms +ve.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit. C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
20.1.42	260 cc. 0.89mgm%	110 cc. 1.60mgm%	2.31mgm.	1.76mgm.	700mgm. A.A. Daily.
23.1.42	460 cc. 1.82 "	220 cc. 13.33 "	9.37 "	29.33 "	Saturated, gums still bleed on cleaning.
27.1.42	500 cc. 3.33 "	300 cc. 40.0 "	16.65 "	120.0 "	No bleeding, Gum Smear Vincents Organisms -ve. Discharged.

SUMMARY:

A case of Vincents Stomatitis, both bacteriologically and clinically, showing a mild degree of unsaturation: cured clinically and bacteriologically in 7 days with 4,900 mgm. Ascorbic Acid. No relapse as far as is known. Was saturated in 3 days.

2.

JACKSON, George, O/Sea., age 19, Trainee, Admitted 27.1.42.

Complained of sore throat and dysphagia - 2 days. On examination fauces were inflammed and plum coloured, bleeding on pressure. Gums: much retraction. Smear: Vincent's Organisms +ve. Bleeding on pressure.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit. C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
27.1.42	340 cc. 2.50mgm%	40 cc. 2.85mgm%	8.50mgm.	1.14 mgm.	700mgm. A.A. Daily.
29.1.42	220 cc. ?5.00 "	260 cc. 2.07 "	11.0 "	5.28 "	No bleeding, Throat: no pain and less inflammed.
31.1.42	220 cc. 2.35 "	210 cc. 4.0 "	5.17 "	8.40 "	No bleeding, throat normal, Gum Smear: Vincent's Organisms -ve. Discharged.

SUMMARY:

A case of Vincent's Angina clinically and bacteriologically showing a mild degree of unsaturation: cured in 4 days with 2,800 mgm. Ascorbic Acid. No relapse as far as is known, and was saturated in 4 days.

3.

BURNETT, Malcolm, O/Sea., age 20, Trawlerman,
Admitted: 30.1.42.

Complained of sore throat for 2 days.
On examination: teeth - many carious. Typical Vincents Ulcer Left tonsil. Cervical glands enlarged. Gums: healthy. Tonsillar Smear:- Vincents Organisms +ve.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
31.1.42	100 cc. 1.33mgm%	40 cc. 2.35mgm%	1.33mgm.	0.94mgm.	700 mgm. A.A. Daily.
3.2.42	220 cc. 2.35 "	220 cc. 4.0 "	5.17 "	8.8 "	Ulcer healing, no dysphagia, cervical glands not tender and smaller.
4.2.42	280 cc. 3.07 "	80 cc. 20.0 "	8.60 "	16.0 "	Saturated.
5.2.42	240 cc. 2.85 "	100 cc. 40.0 "	6.84 "	40.0 "	Ulcer practically healed, A.A. reduced to 100 mgm. per day.
11.2.42	200 cc. 3.01 "	240 cc. 36.0 "	6.02 "	86.4 "	Fauces normal, feels very fit. Tonsillar Smear: Vincents Organisms -ve. Discharged to D.O. for attention to carious teeth.

SUMMARY:

A case of Vincents Ulceration of the tonsil showing a marked degree of unsaturation and cured in 12 days by 4,700 mgm. A.A. No relapse as far as is known. Was saturated in 5 days.

4.

HISCOCK, Sylvester, O/Sea., age 22, Trawlerman,
Admitted: 27.1.42.

Complained of General malaise and aching pains in jaw.

On examination: afebrile, impacted and infected left molar. Gums: spongy, soft and bleeding with a red margin.

Gum Smear: Vincent's Organisms +ve. Given 700 mgm. A.A. daily.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit C. Content in mgm.	REMARKS.
3.2.42	140 cc. 1.60mgm%	120 cc. 13.33mgm%	2.24mgm.	16.0mgm.	Saturated.
4.2.42	80 cc. 3.63 "	120 cc. 13.33 "	2.90 "	16.0 "	Gums healthy, molar still painful. Gum Smear: Vincent's Organisms -ve. Discharged to D.O. for extraction impacted molar.

SUMMARY:

A case of Vincent's Disease of the Gums cured in 8 days by 5,600 mgm. A.A. No relapse as far as is known, was saturated in 6 days.

5.

KING, Albert E., Sea., age 23, Trawlerman, Admitted 28.2.42.

Complained of painful and bleeding gums - 6 months. Reported on two previous occasions and received mouth washes only (? Pot. Chlor.) with only transient improvement. Fauces: normal, lassitude and general weakness marked. Diet:- Potatoes appear to be only source Vit. C taken. Gum Smear:- Vincent's Organisms +ve.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit. C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
1.3.42	220 cc. 2.85mgm%	300 cc. 1.18mgm%	6.27mgm.	3.54mgm.	700 mgm. A.A. Daily.
3.3.42	220 cc. 3.07 "	320 cc. 2.35 "	6.75 "	7.52 "	Gums firmer, less inflammation, only slight bleeding on pressure.
6.3.42	300 cc. 3.33 "	140 cc. 3.07 "	9.99 "	4.30 "	Slight bleeding on pressure.
8.3.42	240 cc. 2.06 "	360 cc. 20.0 "	4.94 "	72.0 "	Saturated, still some bleeding on pressure.
10.3.42	260 cc. 6.67 "	240 cc. 80.0 "	17.34 "	196.0 "	Slight bleeding between incisors only: A.A. reduced to 100 mgm. per day.
16.3.42	-	-	-	-	No bleeding but slough between teeth not clearing. To D.O. - teeth scraped and syringed with H_2O_2.
17.3.42	-	-	-	-	Repeat Dental treatment.
18.3.42	-	-	-	-	No bleeding, no tenderness. Smear: Vincent's Organisms -ve. Discharged.

SUMMARY:

A long standing case of Vincent's infection of the gums showing not only local but general signs of Vitamin C. deficiency. Cured in 18 days by 7,800 mgm. Ascorbic Acid, together /

SUMMARY: contd.

together with a small amount of mechanical dental treatment.

No relapse as far as is known, was saturated in 8 days.

6.

McMAHON, T.S., O/Sea., age 24, Trainee, Admitted 9.3.42.

Complained of sore and bleeding gums 14 days.
On examination:- Gums spongy and bleeding freely on on light pressure. Fauces: normal. Gum Smear: Vincents Organisms +ve.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
10.3.42	100 cc. 0.44mgm%	360 cc. 0.65mgm%	0.44mgm.	2.34mgm.	700mgm. A.A. given daily.
12.3.42	420 cc. 0.75 "	440 cc. 1.00 "	3.15 "	4.40 "	Still bleeding on pressure.
14.3.42	500 cc. 1.08 "	460 cc. 20.0 "	5.40 "	92.0 "	Saturated, still bleeding on pressure.
17.3.42	220 cc. 3.08 "	300 cc. 40.0 "	6.78 "	120.0 "	Gums healthy, slight bleeding still between teeth. A.A. reduced to 100 mgm. per day.
20.3.42	-	-	-	-	Still slight bleeding between teeth. Smear: Vincents Organisms +ve. H_2O_2 mouth washes t.i.d. added.
24.3.42	-	-	-	-	Gums firm and healthy, no bleeding on firm pressure. Smear: Vincents Organisms -ve. Discharged.

SUMMARY:

A moderately severe case of Vincent's infection of the gums showing a fairly marked degree of unsaturation. Cured in 14 days by 5,500 mgm. Ascorbic Acid. No relapse as far as is known, saturated in 4 days.

7.

FOWLER, Harold J., A.B., age 22, Trainee - 3 weeks previously in armed merchant cruiser, Admitted 13.3.42.

Complained of soft, sore and bleeding gums periodically for one year. Treated by mouth washes and iodine but has always recurred. Has avoided most Vit. C. containing foods until recently.

On examination:- Gums soft, with an inflammed margin, bleeding on pressure. Fauces: healthy. Gum Smear:- Vincents organisms +ve.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit. C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
14.3.42	480 cc. 0.58mgm%	320 cc. 0.29mgm%	2.78mgm.	0.93mgm.	700 mgm. A.A. daily.
16.3.42	460 cc. 1.74 "	260 cc. 2.07 "	8.00mgm.	5.38mgm.	
17.3.42	460 cc. 2.0 "	280 cc. 80.0 "	9.2 "	224.0 "	Saturated, no pain, gums still bleed on pressure.
18.3.42	560 cc. 1.14 "	240 cc. 40.0 "	6.38 "	96.0 "	No pain, gums firm, no bleeding on pressure. Discharged as he is required urgently.

SUMMARY:

A mild but long standing case of Vincent's Infection of the gums, showing a fairly marked degree of deficiency. Cured in 4 days by 2,800 mgm. Ascorbic Acid. No relapse as far as is known. Saturated in 4 days.

8.

HALL, Henry, A.B., age 22, Trawlerman, Admitted 16.3.42.

Complained of toothache, preceeded by painful and bleeding gums for 1 week. Right lower molar extracted 4 days previous.

On examination:- Odour and clinical appearance of Vincent's Disease of the gums - most marked in the region of the lower molars bilaterally. Smear: Vincent's Organisms +ve. Has subsisted for many months on tinned vegetables, fresh potatoes and jam.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit. C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
17.3.42	360 cc. 0.8mgm%	600 cc. 0.72mgm%	2.88mgm.	4.32mgm.	700mgm. A.A. given daily.
20.3.42	540 cc. 1.67 "	240 cc. 2.00 "	9.01 "	4.81 "	
23.3.42	500 cc. 2.0 "	200 cc. 1.33 "	10.0 "	2.66 "	Developed acute Follicular Tonsillitis
25.3.42	500 cc. 1.60 "	240 cc. 20.0 "	8.0 "	48.0 "	Saturated, gums no longer bleeding on pressure.
26.3.42	400 cc. 3.33 "	200 cc. 20.0 "	13.32 "	40.0 "	Discharged to Hospital for Tonsillectomy.

SUMMARY:

An acute case of Vincent's Angina showing a fairly marked degree of deficiency and developing an acute Tonsillitis during treatment. Clinical cure attained in 9 days with 6,300 mgm. Ascorbic Acid, saturated in 8 days.

9.

HENDERSON, Joseph, O/Sea., age 26, Trainee, Admitted 5.5.42.

Pyorrhoea and bleeding gums of several weeks duration. Blocked naso-lachrymal ducts. Acute gastritis, chronic Bronchitis. Gums:- Soft, retracted, mild bleeding, some tenderness.
Smear:- Vincent's organisms ++ve.
Diet:- Deficient in Vit.C. for many months.

Date:	Morning Urine Vit.C. Content in mgm%	6 Hr.Urine Vit.C. Content in mgm%	Morning Urine Vit.C. Content in mgm.	6 Hr.Urine Vit.C. Content in mgm.	REMARKS.
6.5.42	360 cc. 1.82mgm%	160 cc. 1.08mgm%	6.55mgm.	1.73mgm.	700mgm.A.A. given daily.
13.5.42	360 cc. 1.43 "	200 cc. 1.29 "	5.15 "	2.58 "	Gums still bleeding and spongy.
15.5.42	280 cc. 1.33 "	280 cc. 0.90 "	3.72 "	2.52 "	Still unsaturated, with spongy and bleeding gums. Vincent's Organisms +ve. Discharged to Hospital for medical treatment.

SUMMARY:

A case of Chronic Vincent's Stomatitis showing a severe degree of unsaturation; still unsaturated at the end of 9 days having received 6,300 mgm. Ascorbic Acid and still with clinical and bacteriological signs of infection. Discharged to Hospital in my absence for treatment for Chronic Bronchitis etc.

10.

JARDINE,L.,O/Sea.,age 20,Trawlerman,Admitted 23.6.42.

Painful and bleeding gums and cheeks of 1 weeks duration. Discharged from Hospital cured of Vincents infection 14 days ago (H_2O_2 mouthwashes: Pot.Chlor.tablets 0.45 gm. N.A.B.,i.v.i.). Now severe sloughing and ulceration inner side lower lip and both upper and lower gums. Tonsils and pharynx plum coloured, no ulcers seen. Cervical glands palpable and tender. Looks pale and run down. Temperature and Pulse normal.

Gum Smear: Vincent's Organisms +++ve.
Teeth: Several carious.
Diet: Has had very little fruit and green vegetables lately. Takes potatoes and root vegetables sparsely.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr.Urine Vit. C. Content in mgm%	Morning Urine Vit.C.Content in mgm.	6 Hr.Urine Vit.C. Content in mgm.	REMARKS.
24.6.42	300 cc. 0.89mgm%	180 cc. 1.33mgm%	2.67mgm.	2.39mgm.	700 mgm.A.A. given daily.
26.6.42	460 cc. 0.67 "	200 cc. 0.85 "	3.08 "	1.70 "	
27.6.42	440 cc. 0.83 "	100 cc. 1.43 "	3.65 "	1.43 "	
29.6.42	500 cc. 0.57 "	420 cc. 0.54 "	2.85 "	2.27 "	Ulcers healing on lip.Lower gum still badly infected. Cervical glands not palpable.
30.6.42	500 cc. 0.91 "	100 cc. 1.33 "	4.55 "	1.33 "	
1.7.42	500 cc. 0.85 "	340 cc. 4.00 "	4.25 "	13.6 "	
2.7.42	500 cc. 1.47 "	460 cc. 10.00 "	7.35 "	46.00 "	Saturated, ulcers healing. Gums still painful and bleeding. Is much better colour and feels much fitter.H_2O_2 Mouthwashes added t.i.d.
3.7.42	500 cc. 1.00 "	360 cc. 13.33 "	5.00 "	47.99 "	

10 Contd. JARDINE,L.,O/Sea., age 20,Trawlerman.

Date:	Morning Urine Vit.C. Content in mgm%	6 Hr.Urine Vit.C. Content in mgm%	Morning Urine Vit.C. Content in mgm.	6 Hr.Urine Vit.C. Content in mgm.	REMARKS.
7.7.42	500 cc. 2.67mgm%	400 cc. 20.0mgm%	13.35mgm.	80.0mgm.	Ulcer and gums markedly improved. Slight bleeding on pressure. No pain.
10.7.42	500 cc. 1.14 "	300 cc. 13.30 "	5.70mgm.	39.9mgm.	
12.7.42	500 cc. 1.33 "	200 cc. 40.0 "	6.65mgm.	80.0mgm.	Ulcers healed. Gums still red and spongy. Slight bleeding on pressure. Smear:Vincent's Organisms +ve. Referred to D.O. for scaling and removal of carious teeth.
16.7.42	500 cc. 1.45 "	200 cc. 45.0 "	7.25mgm.	90.0mgm.	Gums still spongy. Smear:Vincent's Organisms +ve.
20.7.42	-	-	-	-	Reduce A.A.to 100 mgm.per day. Is a fine colour and feels very fit.
22.7.42	-	-	-	-	Gums still slightly spongy, no bleeding. Smear:Vincent's Organisms +ve. 0.45gms.N.A.B. i.v.i.,2 upper canines removed by D.O.
25.7.42	-	-	-	-	Gums firm,no bleeding. Smear:Vincent's Organisms -ve. Discharged.

10 Contd. JARDINE,L.,O/Sea.,age 20,Trawlerman,Admitted 23.6.42.

SUMMARY:

A severe recurrent case of Vincent's Angina with ulceration of both the mucosa of the cheek and gums. Required 8 days to saturate (5,600 mgm. A.A.),18 days to heal the ulcer (18,600 mgm. A.A.) Vincent's Organisms still demonstrable between the teeth after 29 days. Received dental treatment and 0.45 gms. N.A.B.,i.v.i. Discharged clinically and bacteriologically cured after 32 days. No recurrence as far as is known.

11.

McELROY, Wm., O/Sea., age 20, Trawlerman, Admitted 24.6.42.

Sore and bleeding gums for 1 week. Gums soft, inflammed with red margin and bleeding on slightest pressure, particularly in region of lower molars, tonsils pharynx plum coloured but no ulceration. Cervical glands tender and palpable. Gum Smear: Vincent's Organisms +++ve.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
24.6.42	460 cc. 1.08mgm%	300 cc. 1.48mgm%	4.97mgm.	4.44mgm.	700 mgm. A.A. Daily.
26.6.42	440 cc. 0.75 "	80 cc. 1.33 "	3.30mgm.	1.06mgm.	
27.6.42	440 cc. 1.43 "	400 cc. 1.67 "	6.29mgm.	6.68mgm.	
28.6.42	400 cc. 1.25 "	200 cc. 1.70 "	6.00mgm.	3.40mgm.	
29.6.42	220 cc. 1.60 "	180 cc. 13.33 "	3.52mgm.	23.99mgm.	Saturated. Gums painless and firmer but still some bleeding.
30.6.42	260 cc. 1.82 "	220 cc. 40.0 "	4.73mgm.	88.0mgm.	
1.7.42	500 cc. 1.60 "	200 cc. 80.0 "	8.0 mgm.	160.00mgm.	Still slight bleeding on pressure. A.A. reduced to 100 mgm. per day.
7.7.42	-	-	-	-	Gums firm, no bleeding, slough still between teeth. Gum Smear: Vincent's Organisms +ve.
12.7.42	400 cc. 2.35 "	100 cc. 40.0 "	9.40 mgm.	40.0 mgm.	Smear between teeth. Vinc-:ent's Organisms +ve. To D.O. for scaling - no other treatment.

11. Contd. McELROY, Wm., O/Sea., age 20, Trawlerman.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit. C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
21.7.42	-	-	-	-	Gums clinically cured. Smear: Vincents Organisms +ve. 0.45 gm. N.A.B. i.v.i.
25.7.42	-	-	-	-	Gums firm, no bleeding. Smear: Vincents Organisms -ve. Discharged.

SUMMARY:

A severe case of Vincent's Angina which took 5 days to saturate (3,500 mgm. A.A.) and still gave a positive smear from between the teeth after 27 days (6,700 mgm. A.A.). The teeth were scaled and he received 0.45 gm. N.A.B., i.v.i. and was discharged clinically and bacteriologically cured after 31 days.

12.

NORTHROP, Arthur, O/Sea., age 19, Trawlerman, Admitted 20.7.42.

Sore and bleeding gums 1 week. Previously treated by mouthwashes and Gentian Violet 14 days before. Severe ulceration lower gum in region of molars with retraction and a red margin. Bleed on slightest pressure. Tonsils and Pharynx N.A.D. Cervical glands tender and enlarged. T.99.0, P.80. Gum Smear: Vincent's Organisms +++ve.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit. C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
21.7.42	400 cc. 1.33mgm%	200 cc. 1.60mgm%	5.32mgm.	3.20mgm.	700mgm. A.A. daily.
23.7.42	300 cc. 1.48 "	300 cc. 1.33 "	4.44 "	3.99 "	
24.7.42	500 cc. 1.74 "	240 cc. 2.22 "	8.70 "	5.33 "	
26.7.42	450 cc. 1.60 "	250 cc. 2.00 "	7.20 "	5.0 "	
27.7.42	300 cc. 2.0 "	100 cc. 10.0 "	6.0 "	10.0 "	Saturated, gums still spongy & bleeding on pressure. Cervical glands N.A.D.
28.7.42	500 cc. 1.33 "	300 cc. 20.0 "	6.65 "	60.0 "	A.A. reduced to 100 mgm./day. H_2O_2 mouth washes t.i.d.
2.8.42	-	-	-	-	Improved, gums firm, no bleeding. Smear between teeth Vincents Organisms +ve. To Dental Officer for scaling and syringing.
9.8.42	-	-	-	-	Clinically cured. Gum Smear: very scanty growth Vincents Organisms. Discharged.

SUMMARY:

A severe recurrent case of Vincent's Angina saturated in 6 days (4,200 mgm.A.A.) and still giving a positive smear after 12 days. (4,800 mgm.A.A.) a very scanty growth only was obtained after 15 days and since the case was clinically cured he was discharged to duty. No recurrence as far as is known.

13.

BROGAN, M.,Sto.,age 34,Ships Company,Admitted 20.7.42.

Sore and bleeding gums 1 week. Gums soft, tender and bleeding on the slightest pressure. Retracted with a red margin. Worst in lower jaw and involves both lower molar regions. Cervical glands tender and palpable.
Gum Smear: Vincents Organisms +++ve.

Date:	Morning Urine Vit.C. Content in mgm%	6 Hr.Urine Vit.C. Content in mgm%	Morning Urine Vit.C. Content in mgm.	6 Hr.Urine Vit.C. Content in mgm.	REMARKS.
21.7.42	400 cc. 2.11mgm%	300 cc. 1.25mgm%	8.44mgm.	3.75mgm.	700mgm. A.A. daily.
23.7.42	500 cc. 0.80 "	500 cc. 0.98 "	4.0 "	4.90 "	
24.7.42	500 cc. 0.80 "	260 cc. 1.33 "	4.0 "	3.46 "	
26.7.42	450 cc. 2.0 "	300 cc. 10.0 "	9.0 "	30.0 "	Saturated. Gums much improved, Still bleeding on pressure.
27.7.42	500 cc. 1.14 "	260 cc. 20.0 "	5.70 "	52.0 "	A.A. reduced to 100 mgm/day
29.7.42	-	-	-	-	Much improved. No bleeding, breath fetid, ?pyorrhoea molars. Vincents Orgs. +ve. To D.O. for intensive scaling etc.
4.8.42	-	-	-	-	Improved, still under dental treatment.
9.8.42	-	-	-	-	Clinically cured. Smear: Vincents Organisms -ve. Discharged.

SUMMARY:

A severe case of Vincent's Angina showing a severe degree of unsaturation. Saturated in 5 days (3.500 mgm A.A.) and still giving a positive film after 8 days. Following mechanical dental treatment he was discharged to duty clinically and bacteriologically cured in 19 days. No recurrence as far as is known.

14.

HYETT, Cecil T., A.B., age 22, Trawlerman, Admitted 23.7.42.

Sore and bleeding gums and cheeks 4 days. Gums soft, inflammed with a red margin, bleeding on slight pressure. Small sloughing superficial ulcers with a red margin on buccal surface lower lip. Cervical glands palpable and tender. Gum Smear: Vincent's Organisms +ve.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit. C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
23.7.42	400 cc. 1.33mgm%	140 cc. 2.67mgm%	5.32mgm.	4.74mgm.	700mgm. A.A. Daily.
24.7.42	300 cc. 2.00 "	260 cc. 1.82 "	6.0 "	4.73 "	
26.7.42	350 cc. 1.50 "	450 cc. 2.0 "	5.25 "	9.0 "	
27.7.42	400 cc. 1.43 "	500 cc. 10.0 "	5.72 "	50.0 "	Saturated, ulcer healing, gums firmer, still bleeding.
28.7.42	540 cc. 1.60 "	240 cc. 40.0 "	8.64 "	96.0 "	A.A. reduced to 100 mgm/day. H_2O_2 mouth washes t.i.d.
30.7.42	-	-	-	-	Ulcer healed. Gums firm, no bleeding. Teeth in very good condition. Smear: Vincent's Organisms -ve. Discharged.

SUMMARY:

A moderately severe case of Vincent's Stomatitis showing a fairly severe degree of unsaturation. Saturated in 5 days (3,500 mgm. A.A.) and cured bacteriologically and clinically in 7 days (3,700 mgm. A.A.) with teeth in an abnormally good condition. No recurrence as far as is known.

SERIES 6.

COMPARATIVE ANALYSIS OF ASCORBIC ACID SATURATION

of 36 Cases of GINGIVITIS and 100

Healthy Ratings.

(1) Healthy Ratings (from Series 1)

Saturated	15%	
Mildly unsaturated	60%)	85%
More severely unsaturated	25%)	
	100%	

Average number of days required to saturate (from Series 2 & 3) 3 days.

(2) Cases of Gingivitis (from Series 4)

Saturated	0 = 0%
Mildly unsaturated	4 = 12.2%
More severely unsaturated	32 = 88.8%
	36 =100%

No. of cases failing to respond to treatment.	Nil.
Average No. of days required to saturate (all cases)	5 days.
Average No. of days required to cure clinically (all cases)	14 days.
Average number of days required to cure bacteriologically (all cases but one)	14 days.
No. of cases requiring additional dental treatment of gums to cure i.e. scaling and H_2O_2 syringing.	5 cases.
Average No. of days required to saturate clinically severe cases.	6 days.
Average No. of days required to cure clinically severe cases.	16.8 days.
Range of No. of days required to cure all cases.	4-31 days.
Recurrence rate (as far as is known)	Nil.
No. of cases previously treated by local measures and recurring, were treated successfully by Ascorbic Acid.	5 cases.

(3)

Comparison of 1 & 2.

(I) Amongst the cases of Gingivitis none were found to be saturated (i.e. 100% unsaturated compared with 85% amongst the healthy).

(II) There is a marked increase in the percentage of the more severely unsaturated amongst the cases of Gingivitis (88.8% compared with 25%)

(III) The cases of Gingivitis took 2 days longer to saturate in the average (5 days compared with 3, i.e. 1.400 mgm. more Ascorbic Acid) while amongst the clinically more severe cases they took longer still (6 days, i.e. 2.100 mgm. more Ascorbic Acid).

(IV) The severer the case the longer it took to cure (16.8 days on an average compared to 14 days), 5 cases only (35%) required further dental treatment of the gums, chiefly scaling to complete cure. Two severe cases were given 0.45 gm. N.A.B., i.v.i. after saturation with Ascorbic Acid and responded immediately.

(V) None of the cases recurred as far as is known.

(VI) 5 cases (2 of 6 months or more standing) had been previously treated by local measures and recurring were successfully treated by Ascorbic Acid.

SERIES 7.

CASE HISTORIES of 4 Ratings suffering from VINCENTS STOMATITIS and receiving no treatment apart from normal dental hygiene.

1.

BOXALL, J., O/Sea., aet. 20 years, Trawlerman, Admitted 3.8.42.

Complained of painful and bleeding gums and cheeks - 4 days. No previous history.

On examination:- Severe Vincents Infection around right lower molars. Gums all spongy and bleeding on pressure. Tonsils and fauces injected. Cervical glands tender and palpable. T.97.4, P. 80.

Gum Smear:- Vincents Organisms +++ve.

Diet:- No fruit, but little green veg., potatoes etc., no jams.

Treatment:- Normal Dental Hygiene.
Soda Mint. tabs. 1 t.i.d.

13.8.42 No improvement. Ulcers painful and bleed freely on slightest pressure. Cervical glands still palpable. Given 700 mgm. Ascorbic Acid daily.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit. C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
13.8.42	140 cc. 1.0 mgm%	340 cc. 2.0 mgm%	1.40 mgm.	6.80 mgm.	
15.8.42	-	-	-	-	No pain. Otherwise i.s.q.
18.8.42	500 cc. 1.72 "	200 cc. 40.0 "	8.60 mgm.	80.0 mgm.	Saturated. A.A. reduced to 100 mgm. per day.

21.8.42 Much improved but still some ulceration around molars. 0.45 gm. N.A.B. i.v.i. Pot. Chlor. tabs. to suck 6 per day. H_2O_2 mouthwashes t.i.d., to D.O. for scaling etc.

26.8.42 Gums much improved. Developed Herpes Zoster R. side of chest.

30.8.42 Gums healed. Smear - Vincents Organisms -ve.

1 continued BOXALL, J., O/Sea., aet 20, Trawlerman.

SUMMARY:

A severe case of Vincent's Gingivitis, showing no improvement after 10 days on Sick Bay messing and normal dental hygiene. Demonstrably deficient in Vitamin C, was cured in 17 days on 700 mgm. Ascorbic Acid daily till saturated (5 days) and then 100 mgm. A.A. daily + local and parenteral treatment.

2.

WELSH, Edwin, Sto., aet. 19 years, Trawlerman, Admitted 12.8.42.

Complained of sore throat on swallowing of 24 hours duration. States a wooden splinter was removed from the throat by Ship's cook 3 days previously.

On examination:- T.97.2., Pulse 90. Both tonsils markedly enlarged, L. plum coloured. R. covered with a foul smelling, white slough, easily detached and leaving a bleeding surface.

Gums:- Inflammed, spongy and bleeding throughout.
Cervical Glands:- much enlarged and tender bilaterally.
Gum Smear:- Vincent's Organisms +++ve. P.C.+++ve.
Tonsillar Smear:- Vincent's Organisms +++ve. P.C.+++ve.
Teeth:- Many carious.
General Condition:- Is very pale, pasty and easily tired.

14.8.42 T.97, P. 86. Still much pain and difficulty in swallowing. Tonsillar ulcer spreading.

19.8.42 T.97.4, P.80. Swallowing now extremely painful and difficult. Gums bleed freely on slightest pressure. Both tonsils covered with membrane. Cervical glands more tender. To be given 700 mgm. Ascorbic Acid daily.

Date:	Morning Urine Vit C. Content in mgm%	6 Hr. Urine Vit. C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
20.8.42	450 cc. 1.13mgm%	300 cc. 1.33mgm%	5.09 mgm.	3.99 mgm.	
22.8.42	500 cc. 2.0 "	300 cc. 6.67 "	10.0 mgm.	20.0 mgm.	Tonsils healing, less pain. H_2O_2 m.w. t.i.d. and gargles.
26.8.42	420 cc. 2.0 "	250 cc. 25.0 "	8.4 mgm.	62.5 mgm.	Tonsillar ulcers much improved. Gums firmer and do not bleed so readily. A.A. reduced to 100 mgm./day. Pot. Chlor. tabs. to suck 6/day.

2 continued. WELSH,Edwin, Sto.,aet. 19 years, Trawlerman.

1.9.42 Improvement continues. 0.45 gm. N.A.B. i.v.i., to Dental Officer for local therapy and attention to teeth.

4.9.42 Gums firm, tonsils healed. Gum smear and tonsil smear - Vincent's Organisms -ve.

SUMMARY:

A severe case of Vincent's Angina, demonstrably deficient in Vitamin C and showing no improvement after 7 days on Sick messing and normal dental hygiene. Cured in 15 days on 700 mgm. A.A. daily till saturated (6 days) and then 100 mgm. A.A. daily and local and parenteral treatment.

3.

CLANCY, John, W/M., aet. 25 years, Trawlerman, Admitted 10.8.42.

Complained of sore and bleeding gums, sore throat on swallowing of 1 weeks duration.

On examination:- Severe gingivitis upper and lower molar regions, bleeding on the slightest pressure, particularly in the right.

Gums:- Soft and spongy.

Tonsils:- Red and inflammed, no slough or membrane.

Gum Smear:- Vincents organisms +++ve.

Treatment:- Normal dental hygiene.
Tabs. Soda Mint. 1 t.i.d.

15.8.42 No improvement. Gums still painful.
20.8.42 i.s.q. Given 700 mgm. Ascorbic Acid daily.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit. C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
21.8.42	300 cc. 2.22mgm%	100 cc. 2.00mgm%	6.66 mgm.	2.00 mgm.	
26.8.42	240 cc. 1.50 "	300 cc. 20.0 "	2.60 mgm.	60.0 mgm.	Gums healing, No pain, some bleeding on pressure. Reduce A.A. to 100 mgm/day. Pot. Chlor. tabs. to suck 6/day.

2.9.42 Gums firm, no bleeding. Slight ulceration around molars. 0.45 gm. N.A.B. i.v.i. To D.O. H_2O_2 m.w. t.i.d.

4.9.42 Gums healed. Smear - Vincents Organisms -ve.

SUMMARY:

A severe case of Vincents Gingivitis showing no improvement after 10 days on Sick Bay messing and normal dental hygiene. Demonstrably deficient in Vitamin C, was cured in 14 days on 700 mgm. Ascorbic Acid daily until saturated (6 days) and then 100 mgm. A.A. daily and local and parenteral treatment.

4.

COSTELLO, Michael, A.B., aet. 22, Trawlerman, Admitted 22.8.42.

Complained of bleeding and painful gums off and on for 1 year. Previously treated by local measures only at Tobermory, Lowestoft and Glasgow and always recurred.
On examination:- Signs of Gingivitis of both upper and lower gums, bleeding on slight pressure. Cervical glands enlarged and tender. Teeth:- Several carious.
Gum Smear:- Vincents Organisms +++ve.
General Condition:- Pale and easily tired.
Treatment:- Normal dental hygiene. Tabs. Soda. Mint. 1 t.i.d.

31.8.42: No improvement, but condition is not progressing.
Given 700 mgm. Ascorbic Acid daily.

Date:	Morning Urine Vit. C. Content in mgm%	6 Hr. Urine Vit. C. Content in mgm%	Morning Urine Vit. C. Content in mgm.	6 Hr. Urine Vit. C. Content in mgm.	REMARKS.
1.9.42	200cc. 1.10mgm%	350cc. 1.20mgm%	2.20 mgm.	4.20 mgm.	
7.9.42	250cc. 2.00 "	400cc. 30.0 "	5.00 mgm.	120.0 mgm.	Saturated. Gums firmer. Bleeding only from inter-dental papillae. Reduced A.A. to 100 mgm/day.
8.9.42	0.45 gm. N.A.B. i.v.i. H_2O_2 m.w. t.i.d.		Pot. Chlor. tabs. To Dental Officer.		to suck 6/day.
9.9.42	Gums firm, no bleeding. Smear:- Vincent's Organisms -ve.				

SUMMARY:-

A chronic case of Vincent's Gingivitis showing no improvement after 9 days on Sick Bay messing and normal dental hygiene. Demonstrably deficient in Vitamin C and was cured in 10 days on 700 mgm. Ascorbic Acid daily till saturated (6 days) and then 100 mgm. A.A. daily and local and parenteral treatment.

ASCORBIC ACID CONTENT OF FOODSTUFFS.

The following table is quoted from "The Newer Knowledge of Nutrition" by McCollum et al. (1939), p.666 for reference.

x = per 100 ml. Otherwise figures indicate mgm%.

	Mg. per 100 Grams.
CEREALS AND CEREAL PRODUCTS.	
Oats, sprouted, 1 day	2.5
" " 9 days	25.0
" dry	0;11
sprouted, 4 days	20
" 5 days	42
FRUITS.	
Apple, variety unspecified	0.1 to 20.
Appricots	0.8 to 16.
Avocado pear	7.0 ; 13.0
Banana	1.0 to 15
Blueberries	5 to 75
Cherry	3.1 to 17
Currant, black	136 to 220.0
" " juice	132 to 178 X
" red	50
" " juice	44 X
Fig	2.0
" white heart	2.4
" inner	4.9
" outer	5.7
Cape gooseberry	26.5; 49
Gooseberry	27.6 to 47.0
" juice	27.3 X
Grape, white and purple	1.0 to 40
" juice	3.0 X
Grapefruit, juice	26 to 65 X
Guava	56 to 299
Huckleberry	44
Lemon	14.0 to 66
" juice	25.8 to 70.9
" whole peel	100.0
Lime, juice	16.8 X to 62.5 X
" " sweet	31.2 and 58.8 X
" " unripe	68.1 X
" " ripe, fresh	39.6 X
" " " old	23.8 X
Loganberry	20.4 to 48.4
Melon	1.6 to 20
" musk	59
" cantaloupe	15 ; 53.
" water	1.0 to 7.0

FRUITS.

Mulberry	6.6 and 21
Nectarine	24
Olive	15
Orange pulp	16 to 47
" " valencia	38 to 53
" " navel	52 to 98.
" juice	22 to 89 X
" " Californian	63.2 to 70.6 X
" " Sunkist, old	10 X
" " " new	51 X
" " "	32.5 to 64.7 X
Peach	8.0
" Clingstone	8.2 and 11.0
" Elberta	4.5 and 5.7
" Hardstone	8.5
Pear Bartlett	3.6
Persimmon	6.1 to 20
Pineapple	10.4 to 62.9
" juice	5.9 to 75.9
Plum	0.5 to 4.6
" dried prune	1.0
Pomegranate	15.6
Prickly pear, juice	16 and 20 X
Quince	10 and 16
Raspberry	30.5
" juice	20.8 to 32.6 X
Strawberry	46 to 77.5
Tangerine	10 to 36
" juice	10 to 78 X

NUTS.

Almond	0; 19.3
Chestnut, Spanish	32.3 ; 50
Cocoanut	0.4 to 13.4
Hazelnut	15
Walnut	30

VEGETABLES.

Artichoke, Jerusalem	5.8
Asparagus	12
Bean, variety unspecified,dry	1.25
" lima	23 to 61
Betroot, fresh	2.7, 10
Broccoli	68
Cabbage	20 to 124.2
" , early summer	55
" , late autumn	30
" juice	22 X to 93 X
" Chinese	40
Carrot	1.0 to 31
" juice	4.0 X; 23X
" tops	95
Cauliflower	19 to 101
Celery, stalks	1.0 to 5.7

VEGETABLES.

Cucumber	1.0 to 17.8
Dandelion, leaves	8 and 42
Endive	19
Fenugreek	136.7 and 140.7
Grass, fresh	68; 75.3
Horseradish	52 to 160
Iris, leaves	110
Kale	34
Kohlrabi	16 to 100
Leek	4 to 33
" tops	50
Lentil, dry	3.0
" sprouted	15.0
Lettuce	0.5 to 22
Lucerne or Alfalfa, fresh	73 to 380
" " " young plants	310 to 350
" " " flowering stage	225
" " " dried	5.7 to 160
Mint	63
Mushroom	1.9
Mustard leaves	81
" seeds	44
Onion, white	2.6 to 15
" tops	84
" spring	14
Parsley, green	140 to 280.8
" root	14.0
Parsnip, greens	210 to 216
" root	5 to 40
Pea, fresh, green	4.8 to 40
" chick, sprouted	14.2
" cow, leaves	70 to 190
" seeds (cow)	6.7
Peppers, chillies or pimiento, green, fresh	11.7 to 330
Potato	11 to 36
Pumpkin or squash	1.1 to 22
" " " leaves	10 to 160
Radish	20
" pink	16.9
" white	15.0
" leaves	43 to 113.8
Rape, leaves	33; 48.3
" stem	17.8
Rhubarb, stalks	5.9 to 36.7
" juice	27.8 X
" leaves	30
Soy bean leaves	33.3
Spinach	6 to 124
Sprouts, Brussels	71.8 to 146
Sweet corn, young cobs	3.5 to 9
Sweet potato	16 to 91
Tomato	12.9 to 39
" juice	9.2 to 40
Turnip root	17 to 43.4
" juice	19.1 X

VEGETABLES.

Turnip greens	39 to 120
Water chestnut	3.2
Watercress	24 to 76
Yam	6.1

DAILY PRODUCTS.

Milk, cow's, raw	0.3 to 2.89 X
" " " pasture fed	1.64 to 2.18 X
" " " stall fed	1.59 to 2.27 X
" colostrum	1.62 to 3.20 X
" curd from cow's milk	0.7 to 1.0 X
" goat's	0.9;8.5 X
" human	1.2 to 10.8 X

EGGS.

Hen's egg white	0
" " yolk	0
Duck's egg, white	0.3
" " yolk	1.3

FISH, MOLLUSKS AND CRUSTACEA.

Clams, small white	17
" yellow	9.3
Fish, air, liver	16.0 to 114.4
" " muscle	6.0 to 27.7
Mussels, fresh-water	0.82 to 1.96
Roe, mackerel, soft	4.0
" perch, hard	10.0
" salmon, hard	14.0
Shrimp	2.5

MEAT.

Blood,rabbit	2.3
Brain, ox	11.4 to 26.0
Brain, rabbit	15 to 26
Gizzard, chicken	1.7
Kidney, goat	18
" , pig	14
" , rabbit	3.5 to 10
Liver, calf	33
" , chicken	22
" , duck	13
" , goat	26; 73.4
" , ox	24 to 68
" , pig	12 to 38
" , rabbit	8 to 40
" , sheep	25 to 46
Lung, rabbit	10 to 24
Muscle, goat	7
Muscle, rabbit, red	1.1 to 3.4
" , rabbit, white	0.7 to 1.6
" , " , red and white	0.42 to 1.5

MEAT.

Muscle, ox, stomach	15.8 to 20.1
Heart, goat	8
Heart, ox	4.6
" , rabbit	1.1 to 3.0
Pancreas, ox	12.2
Suprarenal, calf	99
" , ox	76 to 185
" , pig	115
" , rabbit	183 to 216
" , sheep	133

MISCELLANEOUS.

Beer	0.2 to 0.5 X
Saurerkraut, canned	8.2 ; 21
Saurerkraut, juice	25 X
Tea, fresh leaves, Russian.	113 to 187