A HISTORICAL INQUIRY INTO THE EFFICACY OF LIME-JUICE FOR THE PREVENTION AND CURE OF SCURVY.¹

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(From the Lister Institute.)

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I.—INTRODUCTION.

The antiscorbutic value of fruit juices was recognized three hundred and more years ago, and the traditional faith in lime juice as a specific remedy and preventive for scurvy is of very old standing. During the wars of the second half of the eighteenth century, this belief was so constantly and so powerfully confirmed that in spite of the great expense and difficulties entailed, a regular supply was eventually adopted by the British Admiralty; and early in the nineteenth century the disease, hitherto a most serious menace to the efficiency of the Navy, was practically eliminated by the introduction of a general issue of so-called "lime juice."

The firm belief in lime juice is not, however, shared by those who in recent years have had occasion to test its value to a practical test. Dis-

¹ A short abstract of the results contained in this paper was published in the Lancet, November 30, 1918.
appointment in its antiscorbutic powers may be traced in the reports of Arctic explorers towards the end of the nineteenth century. During the present war, lime juice prepared from the West Indian sour lime has been issued to troops when the military circumstances rendered an adequate supply of fresh meat and vegetables impossible, and the opinion formed of it by medical officers who have been confronted with outbreaks of scurvy among the troops appears to be equally unfavourable.

An experimental study of scurvy has recently been carried out by a group of workers at the Lister Institute. These researches have largely been devoted to an experimental determination of the relative antiscorbutic value of different foodstuffs, and among these considerable attention has been paid to fresh and preserved fruit juices. The fresh juices of oranges and lemons were found to be among the most potently antiscorbutic of the materials examined; that of the fresh, ripe lime was discovered to be markedly inferior to that of the lemon, and preserved lime juice, as issued to the Services, was found to be useless for the prevention of scurvy by the method employed.

The following historical investigation was undertaken in the hope that light might be thrown upon the divergence between the Naval experience of a century ago on the one hand, and the recent experience with outbreaks of scurvy in man and experiments upon animals on the other. The explanation that has emerged is both satisfactory and simple. It has appeared that the introduction of the juice of the West Indian lime as the lime juice ration in the Navy and Mercantile Marine dates only from the latter half of the nineteenth century, when the faster rate of travel, among other changes, caused a great improvement in the dietary on board ship, and any serious reliance upon the antiscorbutic value of the lime juice carried would be an extremely rare occurrence. In the early part of the nineteenth century, when the lime juice ration often provided the only antiscorbutic food in the sailors' dietary, it was the juice of lemons from the Mediterranean that was employed.

The contrast in the value of these two products is dramatically shown in the experience of two Arctic expeditions, provided respectively with the juice of lemons and of limes, of which a full description is given in the following pages. In other respects the circumstances seem to have been comparable. The "Investigator," commanded by McClure, which went in search of Sir John Franklin, 1850 to 1854, was supplied with lemon juice and enjoyed immunity from scurvy for over two years, notwithstanding great privations. The "Alert" and "Discovery," in 1875, were the first ships on Arctic service to which the preserved juice of West Indian limes was issued. To the dismay of all concerned, severe scurvy broke out after

1 Chick and Hume. 1917. Trans. Soc. of Tropical Medicine and Hygiene, vol. x, p. 141.
the first winter spent in the Arctic circle. The Admiralty Committee appointed in 1876 to inquire into the cause of this outbreak found no satisfactory explanation. It took no cognizance of the change in the nature of the lime juice provided. In the light of the experimental researches mentioned above, this substitution of limes for lemons in the preparation of lime juice appears to have been the cause of the disaster.

II.—What Lime Juice Was and Is.

"... The juice of Lemmons is a precious medicine and well-tried, being sound and good, let it have the chiefe place, for it will deserve it, the use whereof is: It is to be taken each morning two or three spoonfuls, and fast after it two hours, and if you add one spoonfull of Aquavitae thereto to a cold stomach, it is the better. Also if you take a little thereof at night it is good to mix therewith some sugar, or to take the syrup thereof is not amisse. ... In want whereof, use the juice of Limes, Oranges or Citrons, or the pulpe of Tamarinds." So, in his chapter on scurvy, Dr. John Woodall, a surgeon of the East India Company, in "The Surgeon's Mate," which was published in 1617. The knowledge of this precious medicine was not new in his day, and he knew almost as much of the use of it as we do to-day. And in his day there was "a good quantitie of the juice of Lemmons sent in each ship out of England by the great care of the Marchants, and intended onely for the relief of every poore man in his neede, which is an admirable comfort to poore men in that disease." But the knowledge of it did not grow as the need for it grew and multiplied; and the merchants, with the growth and complication of their affairs and the continual increase of shipping failed in this personal great care of the seamen carrying their merchandise; and invention failed to meet the problem of the preserving of a fresh fruit on long voyages. A century and a half later, Dr. Lind became the authority of his day on scurvy, and made a great step forward by his attempt to solve that problem. But when in the second half of the eighteenth century England was involved in war after war, scurvy was still unconquered and its ravages were such as seriously to menace the efficiency of the Navy and thus the safety of the country. Many remedies were tried, more or less ineffective, before the juice of lemons, limes and oranges, proved to be useful by generations of merchant sailors, was adopted and its preparation and issue begun on a large scale.

Recent investigation having thrown doubt on the efficacy as an anti-scorbutic of the lime juice now issued to the Services, it has become desirable to seek in history for any information as to the qualities, the source and preparation of the "lime juice" that was used when its reputation was made in the Navy. The examination of the Admiralty records with

1 Chick and Hume. 1917. Trans. Soc. Tropical Medicine and Hygiene, x, 141.
this object has been disappointing, large series of records having been destroyed, including the medical records; and of those that remain many are chaotic masses, unordered, unindexed, undigested, so that a search for details so remote is laborious and its harvest small. Exact information is the more difficult to obtain because in the early days of the use in the Navy of the citronaceous fruits, there was practically no discrimination between limes and lemons. Again and again the terms "lemon juice" and "lime juice" are used indifferently in the same letter, of the same consignment; either term was applied indiscriminately to the juice of limes and lemons, and the confusion remains to-day. Limes and lemons were taken to be to all intents and purposes the same thing, and the only occasion on which I have found them definitely differentiated in the correspondence of the Sick and Wounded Board, during the time when scurvy was a pressing problem, is in a question of the number of fruits required in the treatment of cases, and so is a reference only to the difference of size between the two fruits.

The two words both derive from a word that takes different forms in different parts of the far East, lemon, limo, lemo, etc., but stands for the whole genus Citrus. The two fruits were differently named in England early, but before the lime was familiar the lemon was called lymon, and later limon and limmon. From the same origin the French derive limon and limonier (Citrus limonum, Risso; our lemon and lemon-tree), but except in the south they use citron for the lemon (an irregularity deprecated by Risso who refuses to conform with it), and limonade and jus de citron represent equally and interchangeably our lime juice and lemon juice, which does not tend to relieve the confusion. Thus in the records—

"The Lemon and the piercing Lime
Their lighter glories blend,"

making it a matter of difficulty to divide and consider their relative virtues or to recognize what fruit exactly was used for the health of the Navy, until one turns to the source of supplies. There at least, in correspondence in connexion with the actual purchase of the fruit, one may expect to find more exact terminology, and from its source to learn what the fruit was.

According to the authorities, Linnaeus, Risso, &c., Citrus medica, includes all citrons, lemons and limes. Risso, in his exhaustive catalogue of the oranges of Europe, calls the lemon C. limonum, and gives the varieties C. limonum vulgaris and C. limonum bignetta as the two most cultivated on the shores of the Mediterranean. They are the lemons of our daily use. It is the C. limonum that is grown exclusively for commercial purposes in the south of Italy. C. limetta is the lime of the south of Europe and was cultivated some centuries ago in the south of France much more than in Risso's time or since. C. limetta hispanica is a variety

grown in Spain from remote times, but the lemon is the more important product there too. In his "Reflections on the Commerce of the Mediterranean," 1 1804, a book that gained the attention and respect of the Admiralty, Jackson does not mention the lime at all, among the exports, but he gives lemons, oranges, lemon juice and the essences of lemon and bergamot in his list of Sicily's important products. The C. limetta is a sweet lime, its juice being but slightly acid; it is hardly distinguishable from C. lumia which is also called sweet lime or sweet lemon, and it is akin to the sweet limes of India.

The sour lime is quite another variety. It is the C. medica, var. acida, and does not occur in Risso's list of the European varieties. Like all the genus Citrus it came from the East Indies, but it was very long ago taken by European colonists to the West Indies, and since the middle of the last century its cultivation there has become a very large industry. It is C. medica acida from which our modern lime juice is procured.

We know, then, that limes from the Mediterranean were sweet limes only and we know that the Italian fruit was lemons only. The West Indian lime is the sour lime, which demands different conditions of climate for its growth.

It is not by any means easy to find the source of the fruit at first used by the Admiralty, as all the contracts of the Sick and Wounded Board have been destroyed, and at first it was the Sick and Wounded Board that bought and issued the juice. From information available in scraps in departmental correspondence, however, it appears that the juice that was used did come from the Mediterranean. For years there was great difficulty in getting enough. The Sick and Wounded Board periodically recommended the extension of its use, to which the Lords Commissioners replied that such was their intention, that they were only waiting for the Sick and Wounded Board whose business it was to find the supply. In 1796 Spain changed over to the French side in the war, thereby reducing the available sources of the fruit and so raising the price. Deficiencies were made up to a certain extent with lemons from Lisbon, but it was, then hoped to get lime juice cheap from the West Indies and inquiries were sent to the victualling agent and to the Commander-in-Chief on the Jamaica station. Reports were received but have not been preserved, and presumably they must have been unfavourable as there is no reference to any supplies coming thence. When, after the Battle of the Nile in 1798, Nelson took possession of Malta, we had in our own control an ample source of supplies of lemon juice, but it is not until September, 1803, that we find the first attempt to get a supply from Malta. The Commander-in-Chief on the Mediterranean, Lord Nelson, was asked to inquire into the possibility of doing so, and the resulting report was so favourable that contracts were immediately formed. (The price quoted for the fruit juice

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was 1s. per gallon, while the London contractors who had supplied the Admiralty from 1794, tendered at the same time a quantity at “8s. per gallon, or, in the event of war with Spain, 9s. per gallon.” Presumably freight was very high then, owing to war risks, as it is now.)

It is possible, then, that the “lime juice” issued before 1804 had in it at least a proportion of the juice of sweet limes as well as of lemons. After that the whole supply until 1860 at least (with the exception of that for the West India squadron from 1846, to which reference is made later) was contracted for at Malta and consisted of the juice of lemons grown in Malta and Sicily. This Malta lemon juice was used for all our ships, and sent not only to Halifax and the Baltic, but to the Cape of Good Hope and to the West Indies, and even the Gibraltar station was supplied from Malta.

III.—INDICATIONS THAT LEMON JUICE (“LIME JUICE”) WAS RESPONSIBLE FOR THE DISAPPEARANCE OF SCURVY FROM THE NAVY AT THE BEGINNING OF THE NINETEENTH CENTURY.

One fact that emerges clear from the Admiralty correspondence is that the regular issue of lemon juice was achieved not all at once, but only gradually over a number of years. In his much-quoted statement, made in the year 1830, that the use of lemon juice in the Navy was begun in 1795, and scurvy “totally rooted out” within two years, Sir Gilbert Blane 1 was swayed by an optimistic enthusiasm, after the work had been accomplished and found to be good.

There was no regular and general issue of lemon juice in the Navy in 1795. Indeed lemon juice was practically one of the things for which the sailors mutinied in 1797. Among the very modest demands drawn up by the companies of fifteen ships in mutiny in April of that year, one was: “That your Lordships will be pleased to look into the state of the sick. . . . that their necessaries be not on any account embezzled.” Another, “That there may be granted a sufficient quantity of vegetables of such kinds as may be most plentiful in the ports to which we go; which we grievously complain and lay under want of.” And an interesting letter 2 of Admiral Waldegrave shows that the seamen knew the value of lemon juice and resented its not being supplied to them. In November, 1897, the Admiral had requested that he might have expenses allowed from last May, for vegetables and lemon juice he had bought, which their Lordships refused, and he appealed again:—

“London, December 2, 1797.

“Evan Nepean, Esq.,

“Sir,—In answer to your letter of 24th ultimo, stating that the Lords Commissioners of the Admiralty conceive it might have been proper for me to have


ordered a supply of lemon juice to H.M.S. 'Pluto' from the time of my receiving the application to that effect, but that they cannot allow of its bearing a retrospect, and will not admit of any charge of that description being brought against the Public, I have to request that their Lordships will be pleased to take into consideration the temper of the times and my own peculiar delicate situation, which not only required of me the nicest judgment to preserve my squadron from breaking out into a determined open mutiny, but also demanded no less management and circumspection to prevent the mutineers from increasing the apparent discontent of the troops and forming a junction with them.

"In this critical situation the 'Pluto's' ship's company applied to me for lemon juice and sugar, the same as had been issued to the 'Latona' and 'Romney,' demanding that the allowance might take place from the time it had been first issued to the latter ship. In this dilemma, being but too sensible how little command I had over the seamen of the squadron, and being apprehensive that I should receive no real support from the troops, I determined to make a virtue of necessity and comply with their request. Were it necessary to call witnesses on the occasion, I could prove that this very measure kept the crew of the 'Pluto' from joining in the mutinous proceedings of the 'Latona,' which had it once taken place. I am certain the troops would have joined in the league, the 'Pluto's' people from their long residence in this country being closely connected with the whole of them.

"(signed) William Waldegrave."

There is a marginal note on this letter, which may be in Sir Gilbert Blane's own handwriting as he was then one of the Commissioners of the Sick and Wounded Board. "December 4: Let me see whether he received the second order about confining the use of lemon juice and sugar to those only on the surgeon's list."

Even in 1801, it was only after some correspondence with the Sick and Wounded Board, of which Sir Gilbert Blane was still a member, and after overcoming obstruction, that Dr. Baird, surgeon on board Lord St. Vincent's flagship, got that full issue of lemon juice to the Fleet during the siege of Brest that secured for it the exceptional record of health triumphantly cited by Sir Gilbert Blane. It was only in August, 1804, that the representations of Dr. Baird to the Lords Commissioners achieved the order that lemon juice and sugar should be issued regularly to the Channel Fleet. Before that it was given only to ships going on foreign service and for the use of the sick.

And so far from scurvy having been stamped out within two years of 1795, thousands of cases continued to occur well into the next century. That they ceased to occur in large numbers in the records of the naval hospitals was due to the fact that in the new sick bay and with the improved knowledge and more uniform treatment of the disease, it was found to be as easily curable on boardship as on shore. Indeed, the swing of that pendulum is shown by the statement of Dr. William Turnbull, in 1806, that it could not be so well cured on land as at sea.

1 "The Naval Surgeon, Comprising the entire duties of Professional men at Sea." William Turnbull, A.M., 1806.
There is no question, however, of the very great value of lemon juice, as demonstrated by the history of individual ships in this period. Where no lemon juice was issued scurvy raged, and when lemon juice or lemons and oranges were supplied, the scurvy was immediately abated or cured. That is a commonplace. But the question of the exact share taken by this important issue in the general very gradual improvement in the conditions of the seamen is complicated by its introduction coinciding with many other changes of enormous importance to the health of the Navy. Apart from the fact that before 1797, owing to the dishonesty of purser's and surgeons, medicines and comforts very often failed to reach the sick men for whom they were issued, the adoption of the issue of lemon juice concurred with the introduction and increasing use of vegetables in the seamen's diet, due to the efforts of Dr. Trotter; with very much improved issues of fresh meat; with more uniform and more considerate treatment of the sick and ailing; with great improvements in the men's quarters; and with the copperplating of ships, making them cleaner and therefore faster, as well as drier. The study of these changes is full of interest, but for the immediate purpose of comparing lemon juice and lime juice it is more useful to go forward to the middle of the nineteenth century and look for any information that may be gleaned round about the time when the change was made by the Admiralty from the one fruit to the other.

During the first half of the century evidence continued to accumulate in favour of "lime juice"—that is, the juice from the Mediterranean. When practically extinct in the Navy, scurvy flourished in the Mercantile Marine, especially in ships sailing to and from the east, and was reduced when the use of "lime or lemon juice" was made compulsory by the Act of 1844; and, again, when the Act of 1867 doubled the compulsory issue (½ ounce increased to one ounce daily), and secured that the juice supplied should reach a certain standard of quality, there was a significant drop in the number of cases received into the Seamen's Hospital.

Measures taken to ensure a pure and unadulterated supply of lemon juice.

The purity of the supply for the Navy was always a matter of much care and concern, and there was difficulty, and sometimes failure, in securing it from adulteration. As was natural, injured or decayed fruit that was not fit to be shipped was made into "lime juice," and in 1853 we

1 7 and 8 Vict. Cap. 112, S. 18, by which the master of every ship must supply lime or lemon juice or other such articles as the Board of Trade may sanction as substitutes, and sugar and vinegar, whenever the crew have consumed salt provisions for ten days; ½ ounce each daily of juice and sugar, and one pint of vinegar weekly.

2 Merchant Shipping Amendment Act, 1867.


4 Jackson, "Commerce of the Mediterranean," 1804.
find the statement without comment in a medical work,1 "Lemon juice has long been regarded as an invaluable antiscorbutic; but, on account of the difficulty of preserving it, crystallized citric acid is usually substituted." From about 1838 complaints were made repeatedly about the quality of the lemon juice being supplied from Malta, but severe therapeutic tests were not then occurring in the ordinary service of the Navy, as the ships were seldom exposed to scurvy conditions. Polar exploration, however, offered opportunities for testing it, and Sir James Ross's expedition of 1848 returned in 1849 with a report of a serious outbreak. The lemon juice supplied to his ships was examined and was found to lack nine parts in ten of the proper acid content. The grave importance of the matter was at once apparent, and Sir William Burnett, Medical Director General, began an exhaustive inquiry. All lemon juice in the victualling stores was analysed, with results showing that all was below the proper standard of acidity, although none of the reports showed so large a deficit as that of the juice brought home by the expedition. The method of preparation was reported on in great detail, and opinions obtained from several chemists as to the point at which it had failed. It appears from these reports that nothing was lacking of care and precision from the moment at which it was delivered to the Naval representatives by the contractors. But the fruit was being gathered in summer, instead of in the first months of the year, when its acid content is greatest, and there was no guarantee that the fruit used was sound. Moreover, the juice was allowed to settle for a month, to clear it, before it was tested for acidity, after which the preservative agent was added, so that, the chemists said, fermentation had probably often begun before the addition of the spirit. And we know now that in that time it had lost considerable antiscorbutic potency. It has to be remembered that lemon juice was a bye-product for the contractors, their principal business being concerned with the rind of the fruit in the preparation of essential oils and crystallized peel. The unsatisfactory standard, or want of standard, of cleanliness, too, of the native workers demanded new clauses and safeguards in later contracts. From that time an officer was sent from Malta to Messina, or wherever juice was bought, to superintend its production in the interests of the Service. To be perfectly sure in the meantime that the other Arctic explorers who were about to leave England should have the best possible, the Medical Director General caused fresh lemons to be bought, and juice to be prepared specially for them at Deptford. He thus secured for them a supply much better than any that was then to be bought in the open market, and the ships furnished with it enjoyed a remarkable immunity from scurvy.

The Efficacy of Lime Juice for the Prevention of Scurvy

IV.—Introduction of Lime Juice Prepared from the West Indian Sour Lime.

The supply of reliable “lime juice” was still not equal to the need when the industry of its production was started in the West Indies by Messrs. Edmund Sturge, citric acid manufacturers of Birmingham, who undertook it, at first on a small scale, when they bought land for the purpose in Montserrat in the early fifties. Lime juice from the West Indies had been tried with a view to its use in the Navy, on the suggestion of the Governor of Bermuda, in 1845. Sir William Burnett, taking up any idea that might lead to the improvement of supplies, caused samples from Bermuda to be tested and compared with Malta samples. The report of the Bermuda juice was so favourable that although its cost was rather more, an order was given in 1846 that H.M. ships stationed there should be supplied with this, the produce of the colony. Eventually, in the sixties, the Admiralty arranged contracts for the whole of its supply of lime juice from the West Indies. This it was enabled to do by the development of the cultivation of the lime in Montserrat, where the production was managed in such a way as to secure the fruit being collected uniformly at the stage of its growth when it is of most value, and to secure also the utmost possible purity of the juice as prepared for use. It was considered very superior to the old supply, was probably much cleaner and stronger in acid, and the Merchant Service adopted it, too, as far as it was available.

The tests of quality were always chemical of course, not therapeutic, and consisted principally in ascertaining the amount of alkali that was neutralized by a given amount of juice. As a matter of fact, it was a mistake to suppose that acidity was necessarily the important element. Pure citric acid was known a hundred years ago to compare unfavourably with the fruit juice in the treatment of scurvy, and yet, by another confusing eccentricity, the surgeons then often spoke of their fresh lemon juice as “citric acid”; it was still supposed that it was the combination of the acids in it that was important. Recently the protective value of lemon juice from which all the citric acid has been extracted, has been tested experimentally, and it has been found to be unimpaired; 1 so that mere alkali tests, although useful as a check on the purity of supplies, were really no just measure of the antiscorbutic potency.

In the meantime a new and momentous change of conditions comes in with the beginning and development of steam navigation. With steam power, voyages were so shortened that ships’ companies were never for many weeks cut off from fresh supplies, so at a stride lime juice was enormously relieved of its responsibility, and tests of its merit thus became fewer. Still, however, the history of Polar exploration gives an opportunity for studying the incidence of disease in definite relation to the

various prophylactics. There we get exact statements of the amounts and kinds of food used, and should be able to make some estimate of the value of different rations. Before 1860 all the juice issued by the Admiralty was the juice of *lemons* from Malta, and it is interesting to compare the experience of Arctic explorers immediately before that date with that of the expedition of 1875, the first that was supplied with the juice of *limes* from Montserrat. In other essentials their conditions were very similar. In that point they differed. Does that difference possibly supply a key to a question hitherto unanswered, the cause of the great contrast in their experiences of scurvy?

V.—(i) EXPERIENCE FROM TWO ARCTIC EXPEDITIONS PROVIDED WITH LEMON JUICE AND LIME JUICE RESPECTIVELY.

When Sir John Franklin sailed with the "Erebus" and the "Terror" in 1845 the problem of a North-West passage to the Indies and Cathay to which so much energy and attention had been devoted by generations of merchants, geographers and sailors, seemed to be very near a solution, but gave precedence, on his failure to return in 1847, to the urgent question of his safety. Then began a series of search expeditions following one another closely, until Franklin's fate was finally ascertained beyond doubt by Sir L. McClintock in 1859. Of the many vessels that took part in the search, a number left England in 1850, and I propose to compare the voyage of one of these in particular, the "Investigator," with the 1875 expedition of Nares on the "Alert" and the "Discovery," because we know that the fruit juice was used in precisely the same manner, with the same safeguards against any variation in the consumption of it, in the two cases.

In 1850, the "Enterprize," Captain Collinson, and the "Investigator," Captain McClure, went round by way of Behring Strait, while Captain Austin's four ships, "Assistance," "Resolute," "Pioneer" and "Intrepid," followed Franklin's route by Barrow Sound. Of the eastern ships, Collinson's, having searched a great part of the coast of America, got home in 1854, and McClure and his companions in the "Investigator" were the first men who actually traversed the North West passage, although the second part of their journey in 1854 was made in a relief ship, the "Investigator" having had to be abandoned, icebound, in 1853. All these ships, although equipped with the utmost care and given all that science or experience demanded as desirable and practicable for the preservation of health, lived necessarily very near the scurvy line, and most of them had more or less experience of scurvy. But in no case did it threaten the efficiency of the ship's crew even after a second winter in the ice; and cases did not often occur before the second winter.

The "Investigator's" crew had the longest term of all in polar seas. Of their experience there is a closely detailed account published in 1858,
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by the Medical Officer, Dr. Armstrong, from the point of view of scurvy solely. His ship's company had a longer period of immunity from scurvy than any previous party engaged on polar exploration, and this immunity Dr. Armstrong attributes solely to the rigid regularity of the issue of good lemon juice. The ship left England in January, 1850, and the first case of scurvy did not develop until the spring of 1852, twenty-seven months after leaving home, and seven months after the principal rations had had to be reduced to two-thirds of the quantities originally thought requisite.

The voyage out, which occupied six months, took the ship twice through the tropics and round Cape Horn. During these six months they had only, of fresh provisions, in the Strait of Magellan, two small bullocks giving a few day's fresh meat, and no vegetables; at the Sandwich Islands, fresh meat for fourteen days and a quantity of vegetables of which the different accounts vary from the "less than fourteen days' supply" of Dr. Armstrong's account to "forty days' supply" of Captain Sherard Osborn's. It was the last party engaged on polar exploration.

That it was enough to be of definite value is shown by Captain McClure's letter to the Admiralty written immediately afterwards. "It gives me great pleasure to say that the good effects of the fruit and vegetables (a large quantity of which we took on board at Oahu) are very perceptible in the increased vigour of the men, who at this moment are in as excellent condition as it is possible to desire, and evince a spirit of confidence and a cheerfulness of disposition which are beyond all appreciation." But it was certainly less than they hoped for, for the visit of the "Enterprize" to the port, just before them, and the annual visit of the American whaling fleet on their way north, had much reduced the resources immediately available.

The ship met with bad weather, being twice dismasted by the violence of the gales, and the conditions for the crew were very arduous; she became leaky and the lower deck was damp and ill-ventilated from the frequent necessity of battening down the hatches. And the air on board continued to be so damp and so impure from there being insufficient fuel to dry and warm it, that cases of ague occurred each winter. Thus the crew did not have a specially favourable preparation for their first winter in the ice, nor did they have specially favourable conditions during their long imprisonment, which lasted for three and a half years before they left their ship. In that whole time there were three deaths from scurvy out of a ship's complement of sixty-five.

As, in 1820, Parry had sighted Banks Land from Melville Island, but had been unable to reach it because of the miles of impenetrable ice of Melville Sound intervening, so in his first autumn McClure sighted Parry's farthest on Melville Island and knew that only those seventy miles of ice lay between him and the making of a North-West passage.

1 "Naval Hygiene and Scurvy," Alex. Armstrong, M.D., R.N. 1868.
2 "McClure's Discovery of a North-West Passage," Sherard Osborn.
He was then drifting fixed in the ice at the north end of Prince of Wales Strait. The current carried him south and he wintered in the Strait, 1850-51. He tried again the next year but found it impossible to get his ship through the ice and so took her south to make another attempt from the western side of Banks Land. He was beset in the ice and had to spend a second winter, 1851-52, in a bay on the north of the island, which he called the Bay of Mercy. He never got his ship out again. He crossed Melville Sound with sledges, expecting to find one of Austin's ships, but all he found was the record of their visit a year before. He left a record on the same stone as Parry's, and returned to spend a third winter, 1852-53, in surely as hopeless a position as ship's company ever waited in. But that ship's company never wavered in courage.

Their rations had had to be reduced in October, 1851, the beginning of their second winter, because of the loss earlier of a boat's load of salt meat, and then the loss of 500 pounds of preserved meat, found to have gone bad owing to fractures made in the tins in packing them in England. In October, 1852, the rations were further reduced and the lemon juice ration was halved so that they were on starvation allowance through the third winter. In May, 1852, scurvy had begun, and now, of course, made rapid strides and the men were mostly too weak and disheartened even to hunt for game. Deer were plentiful however, and they continued to get some. Happily their record was found by one of the "Resolute" slogging parties and Lieutenant Pym arrived just a few days before the date on which it had been arranged that a party should set out to try to reach the coast of North America on foot. One can hardly doubt that their fate would in all probability have been that of Franklin's men who made the same attempt, with much less distance to cover. Eventually, after three and a half years of hardship and much suffering they crossed Melville Sound and were taken on board the "Resolute." They are described by an officer of this ship as looking, on their arrival, like men who were out of their minds. On board the "Resolute," one "Investigator" officer died of consumption, and later, on the "North Star," one man died from the effects of scurvy. All the others recovered. After another winter the "Resolute," along with the others of Belcher's ships, was in her turn abandoned and the "Investigator" veterans completed their North-West passage in the "North Star," "Phœnix," and "Talbot," relief ships.

The immunity from scurvy in the first two years of the "Investigator's" voyage, while exceptionally complete, was not greatly different from that recorded by other British ships of her own time. But the history is far other of that expedition that left England in May, 1875, on board the "Alert" and "Discovery" under Captain George Nares, to try to

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1 By an oversight, it was erroneously stated in the Lancet, November 30, 1918, that the lemon juice ration was reduced in October, 1851, instead of October, 1852.
reach the North Pole. They wintered, the “Discovery” in a bay in Robeson Sound, and the “Alert” on the north-east coast of Grantland, latitude 82° north. After preparatory sledging expeditions in the autumn, the principal sledging parties went out early in April, 1876, Commander Markham going due north and reaching the latitude of 83° 20' 27" N. Lieutenant Aldrich west along the north coast of Grantland, and Lieutenant Beaumont east along the Greenland coast. All three parties were severely attacked by scurvy soon after leaving their ships, the first case occurring within a fortnight in each crew, notwithstanding the fact that the “Alert’s” men, that is, Markham’s and Aldrich’s sledge-crews, had had a double issue of lime juice daily for a month before they started.

The recommendations issued in 1875 to the ships’ commanders by the then Medical Director General, Sir Alexander Armstrong, who had been Medical Officer on the “Investigator,” conclude with the words: “Looking to the fact that this expedition will be one purely of exploration and discovery, and, unlike former ones, will be emancipated from the more trying duties of search, and with a greatly improved dietary and supplied with all modern improvements suitable to the Service, I am of opinion that, if the crews be carefully selected and the sanitary rules strictly enforced, the ships’ companies should enjoy an immunity from scurvy, and a freedom from disease hitherto unknown in Arctic expeditions.” That expectation was shared by all the officers. So well equipped were they that none of them anticipated scurvy; they did not think it a possible danger until at least the second winter, and the medical officers did not even think it necessary to give instructions to the sledging parties for its treatment should it appear.

The first case of scurvy was in January (1876), the patient being a man who had had access to the spirits and was believed to have drunk more than his ration. The case was therefore considered exceptional. No other case occurred until April when the sledges started, but then, with the sudden access of very hard work, scurvy at once developed, not in one or two, but in nearly all the members of the sledging parties. Of Commander Markham’s party of seventeen every man and officer was stricken, and they were unable to complete their journey back to the ship until after a relief party had reached them. News of their plight was brought back by Lieutenant Parr who although suffering himself was still able to walk and did a fine forced march to the ship for help. In the meantime one man had died. Of the western party of eight, Lieutenant Aldrich and one man alone were able to drag the sledge and they were at the end of their strength when a relief party met them. Lieutenant Beaumont, whose party was twenty-four in all, got back near to Polaris Bay, on the other side of the strait from “Discovery’s”

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quarrels, when help reached them, and they had to remain there for some
weeks under medical care before they were able to get back to the ship.
They lost two of their number.

The men on the sledging journeys were, of course, exposed to severe
physical strain, and Sir Alexander Armstrong says he always found that
exceptionally hard work “favoured the development of scorbutic symptoms.
Indeed, it was not an uncommon circumstance to find that men who were
previously more or less debilitated, presented themselves after one day's
very laborious exertion, with symptoms of scurvy well and fully developed.”
His view that incipient scurvy is quickly developed by over-fatigue is largely
supported by other Arctic officers, and confirmed through history. But in
the case of these ships, scurvy was not confined to the men with the
sledges. The men who remained on the ships, who were not subjected to
fatigue at all and who continued to drink their lime juice ration, the “idlers”
as they were called, whose duties were on board ship, also developed scurvy.
By 18th May, “Alert” had a sick list of seventeen, the whole of those left on
board with very few exceptions. The total number of cases in the
expedition was sixty in the first year out, with three deaths, out of 122 men.
This makes a very startling contrast with the previous history. The
“Investigator” in her three-and-a-half terrible years had not more deaths from
scurvy. The “Alert” was home in England within seventeen months
of her departure. The “Investigator” was out for twenty-seven months,
seven months of that time on reduced rations before her first case
developed.

(ii) Official Inquiry into the Causes of the Outbreak of Scurvy
in Nares’ Expedition, 1876.

On the return of “Alert” and “Discovery” to England in October, 1876,
a Committee was appointed to inquire into the reason of the outbreak.
The equipment of the ships had been excellent and the officers had
practically no improvements to suggest. The food supplies had been
on lines that had been tested and proved by other, more fortunate,
expeditions. Lime juice had been issued in accordance with the
instructions of the Medical Director General, in the same way that he had found so
efficacious on “Investigator,” namely, one ounce of lime juice with one
ounce of sugar was consumed each day by each man, in the presence of an
officer. For fully a month before the sledging parties went out a double ration
had been consumed daily on board the “Alert.” No lime juice was taken
out, however, by the early sledging parties. It had not been taken out by
sledging parties on other expeditions, as it was frozen hard in the bottles at
that time of the year and could not have been carried liquid until well on in
May. It would therefore have required that extra fuel should be carried on
the sledges to melt it; and it was not considered necessary.

Sir George Nares in “Journals and Proceedings.”
The Efficacy of Lime Juice for the Prevention of Scurvy

The Committee reported that the early outbreak of scurvy was due to the omission of lime juice from the sledge dietary, and that therefore the orders given by the Commander of the expedition were not proper.

Sir Clements Markham, then Secretary of the Royal Geographical Society, immediately published "A Refutation of the Report of the Scurvy Committee," 1877, in defence of Sir George Nares, in which he examined the evidence exhaustively. He shows that the conclusion does not agree with the bulk of the evidence, that it is in direct opposition to the opinions expressed by a large majority of the old Arctic officers who gave evidence, and of the medical officers of the expedition in question, and that it is only partially supported by the evidence of the other medical witnesses who had not Arctic experience. Nor does it take into account the facts that the first case of scurvy developed long before the sledge journeys started, that other cases occurred among men who never left their ships, and that cases occurred later on sledges that did take lime juice. Throughout the evidence of witnesses there is a reluctance to accept as the cause of the outbreak the stoppage for so short a time of the lime juice issue, but there is no other apparent cause of it. It continues to seem inexplicable, for other expeditions have had the same ration and have had much less illness, although out far longer than this one. Sir Clements Markham proceeds to examine the history of previous expeditions and concludes that "The rule is that Arctic sledging parties have never taken lime juice and have never had scurvy, and there are hardly any exceptions to this rule."

How utterly misleading to the general public that finding of the Scurvy Committee was may be seen from this sentence from the Times leader that appeared on 19th May, 1877: "Had it been possible to transport them instantaneously from England to the point from which their sledge journeys started, and had they then been set on those expeditions without lime juice, they would, according to all existing experience, have fallen victims to scurvy." Nothing could be more untrue. All then existing experience was diametrically opposed to any such conclusion. The Times article is a long, ungenerous condemnation of Sir George Nares for having done exactly what all the great explorers had done before him with impunity. "The means, in fact, were all at hand," it says, "for obviating the disease which is the great enemy of all such enterprises, but by a lamentable failure of judgment they were not used." Admirals Sir George Richards and Sir Leopold M'Climontock, who had been among the greatest sledge-travellers of the Search expeditions, both wrote to the press stating that they had never used lime juice when sledging, and that there was no experienced Arctic officer living who would not have done precisely what Sir George Nares had done. The Report of the Committee simply failed to explain the outbreak of scurvy.
(iii) **Detailed Comparison of the Diet of the Two Expeditions.**

If, then, it is impossible to accept a theory by which all cases of scurvy on the "Alert" and "Discovery" sledges were due to the absence of lime juice from the sledge diet, and all cases on board ship were due to exceptional conditions of constitution or habits in the individuals, what theory does meet the case? What condition obtained to which all were subject and in which they differed from the crews of former ships similarly situated? Was there any important difference in the diet, through these months on board ship, which reduced the men to the point at which scurvy was ready to develop, on the application of sudden strain? In his narrative Sir George Nares quotes from his journal of 9th February, before any sledging parties have gone out, before daylight has returned, "Everyone without exception is complaining of shortness of breath. I certainly do not remember experiencing the same at Melville Island (he was in 'Resolute,' 1852-54). In more than one instance severe running has been followed by blood-spitting in otherwise healthy men." So there was even then a distinct abnormality, and in the direction of scurvy, unremarked, be it noted, by the Scurvy Committee. Does any difference in diet account for it?

The general diet scale of "Alert" and "Discovery" was as recommended by the Arctic Committee, made out on the lines of the former expeditions, with every improvement that experience suggested. Herewith is a table showing the principal items of diet, compared with those of "Investigator's" diet, during first, second and third winters. It should be noted that "Investigator's" officers thought her supplies of meat from the first rather less than ample. Hence an increase in "Alert's" supplies.

The salt beef was the one item in the 1875 food that was not so good as the earlier supplies, in so far that it was too salt. It was the same kind of meat that Sir Edward Belcher's ships had, rumps and rounds of the best quality that could be procured, salted in the ordinary way; but it had absorbed more salt in the process than usual and was not liked.

The preserved vegetables were more varied, and Rear-Admiral Richards, who was in "Assistance" in 1852-54, says: "I think the qualities were in many cases superior in the late expedition (i.e., the 'Alert' and 'Discovery'), because all preserved vegetables are now produced in a higher degree of perfection than they were in our time." It may be that greater perfection of preservation implies greater perfection also of the destruction of vitamins, so that their antiscorbutic value may be still further diminished. But "Alert" and "Discovery" had double "Investigator's" ration, as well as an extra supply of "compressed" vegetables, and double her ration of fruit.

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1 "A Voyage to Polar Seas."

2 Evidence, Scurvy Committee.
I 10 The Efficacy of Lime Juice for the Prevention of Scurvy

<table>
<thead>
<tr>
<th>Winter scale</th>
<th>&quot;Alert's&quot;</th>
<th>&quot;Investigator's&quot;</th>
<th>First winter in ice 1850-51</th>
<th>Second winter in ice 1851-52</th>
<th>Third winter in ice 1852-53</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime juice and sugar</td>
<td>1 oz. each daily (lime)</td>
<td>1 oz. each daily (lemon)</td>
<td>1 oz. each daily (lemon)</td>
<td>1 oz. each daily (lemon)</td>
<td>3 oz. daily (lemon)</td>
</tr>
<tr>
<td>Sugar for bread</td>
<td>3 lb. in four days 9 oz. every 4th day 1 lb. daily</td>
<td>1 lb. daily</td>
<td>2 lb. daily</td>
<td>3 lb. daily</td>
<td>3 lb. daily</td>
</tr>
<tr>
<td>Biscuits</td>
<td>1 gill daily (doubled for some of the winter months)</td>
<td>1 gill daily</td>
<td>3 gill daily</td>
<td>3 gill daily</td>
<td>3 gill daily</td>
</tr>
<tr>
<td>Spirits</td>
<td>1 lb. alternate days</td>
<td>1 lb. alternate days</td>
<td>2 lb. alternate days</td>
<td>2 lb. alternate days</td>
<td>2 lb. alternate days</td>
</tr>
<tr>
<td>Preserved fresh meat</td>
<td>1 lb. alternate days and 1/2 lb. every 4th day</td>
<td>1 lb. alternate days</td>
<td>1 lb. alternate days</td>
<td>1 lb. alternate days</td>
<td>1 lb. alternate days</td>
</tr>
<tr>
<td>Salt or corned meat</td>
<td>1/2 lb. every 4th day 1/2 lb. daily (Edward's potatoes, carrots, onions)</td>
<td>1 lb. per week</td>
<td>1 lb. alternate days (Edward's potatoes, carrots, barley and rice alternately)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Soup</td>
<td>None</td>
<td>3 oz. weekly (cranberries)</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Preserved vegetables</td>
<td>1 oz. every 4th day</td>
<td>6 oz. weekly</td>
<td>6 oz. weekly</td>
<td>7 oz. weekly</td>
<td>7 oz. weekly</td>
</tr>
<tr>
<td>Compressed vegetable</td>
<td>1 oz.</td>
<td>1 lb.</td>
<td>1 lb.</td>
<td>1 lb.</td>
<td>1 lb.</td>
</tr>
<tr>
<td>Fruit</td>
<td>4 oz. per week with extra sugar</td>
<td>6 oz. weekly</td>
<td>1 lb. weekly</td>
<td>1 lb. weekly</td>
<td>1 lb. weekly</td>
</tr>
<tr>
<td>Pickles</td>
<td>7 oz. weekly</td>
<td>6 oz. weekly</td>
<td>7 oz. weekly</td>
<td>7 oz. weekly</td>
<td>7 oz. weekly</td>
</tr>
<tr>
<td>Peas</td>
<td>Less than 1 lb. weekly</td>
<td>1 lb.</td>
<td>1 lb.</td>
<td>1 lb.</td>
<td>1 lb.</td>
</tr>
<tr>
<td>Tea</td>
<td>1 oz. daily</td>
<td>1 oz. daily</td>
<td>1 oz. daily</td>
<td>1 oz. daily</td>
<td>1 oz. daily</td>
</tr>
<tr>
<td>Chocolate</td>
<td>1 oz. daily and extra with fruit</td>
<td>1 oz. daily</td>
<td>1 oz. daily</td>
<td>1 oz. daily</td>
<td>1 oz. daily</td>
</tr>
<tr>
<td>Sugar</td>
<td>1 oz. daily and extra with fruit</td>
<td>1 oz. daily</td>
<td>1 oz. daily</td>
<td>1 oz. daily</td>
<td>1 oz. daily</td>
</tr>
</tbody>
</table>

Suet issued in lieu of flour, 1/4 oz. to 1 oz. flour.

1/2 lb. meat averaged 6 oz. when bone and fat were deducted.

There are two points to be noted here: First, there was a definite difference in the incidence of scurvy in favour of the officers as compared with the men. Why? On the sledge journeys, at first the men had more of the hauling, the severest physical strain, the officers having to pioneer and seek out the path; but as one by one the men failed, the officers had a greater and greater share of the extraordinarily arduous work of digging or pick-axeing a way through the snow or ice-hummocks and dragging the sledges over and through them. As the men became more and more unable even to walk and had to be carried on the sledges, the officers had very much the larger share of the sheer physical work added to their responsibility and anxiety. So, if over-fatigue is considered, there was nothing there in their favour. What else? They had the same food as the men on the sledge-journeys. On board ship, however, through the winter, their diet had included private supplies of wine ("sixteen glasses of wine per week, sherry, port or Madeira, and a bottle of brandy or whisky
every ten days.”) And, beyond the ships’ supplies, “butter, milk, cheese, jams, sauces, soups; rice, hams, tongues and a few vegetables.” Here is a contrast in diet which should count considerably in favour of the officers and it seems to be the only significant difference.

Then there is a second point. There was a marked difference also in the incidence of scurvy as between the two ships, in favour of “Discovery,” which had twenty cases out of a total complement of sixty, as against forty of the “Alert’s” company of sixty-two; or, as eight men of the “Discovery” wintered on the “Alert,” it should rather be put that of fifty-two who spent the winter on the “Discovery,” fifteen men afterwards had scurvy, and of seventy who wintered on “Alert,” forty-five. The difference in latitude of their winter quarters was only that between 82° 27’ and 81° 42’, but the “Discovery” lay in a sheltered bay, and on the land surrounding it there was a certain amount of vegetation, and therefore she got considerably more game in autumn and had fresh meat for fifty-three dinners in ten months, while the “Alert” had only fourteen fresh meals. Here is another contrast then, surely directly referable to the boardship diet. The officers’ gain of weight during the winter averaged on the “Alert” 5 pounds 6 ounces, on the “Discovery” 8 pounds 13 ounces; the men’s gain of weight on “Alert” 3 pounds 4 ounces, on “Discovery” 7 pounds 9 ounces.

Value of Fresh Meat in the Prevention of Scurvy.—The importance of fresh meat can hardly be exaggerated. Given enough fresh meat it may alone form a complete diet. Of course there are cases in history where scurvy occurs with a mixed diet including generous quantities of fresh meat, and it is only one example out of scores, that our soldiers in the Kaffir Campaign of 1846-47 had scurvy while they had “abundance” of fresh meat and biscuit, with rice for their only “vegetable.” But if biscuit and rice had been omitted and they had had more fresh meat and only fresh meat, probably the scurvy would not have appeared. As is the case with fresh milk,1 fresh meat is not sufficiently antiscorbutic to balance a diet of this sort, but where the food consists of nothing but fresh meat, enough of the antiscorbutic element is present to prevent disease.

The Hudson’s Bay Company’s people lived almost entirely on fresh meat and fish, without farinaceous foods at all; with nothing else, indeed, often, all winter. Dr. Rae, a surgeon of the Company for many years, and an active searcher for Franklin, said he had never had scurvy cases in the whole of the Mackenzie River District, and had only heard of it occurring at York Factory, a port on Hudson’s Bay. He says:—“On many parts of the Mackenzie River they cannot grow any vegetables and I know that none are sent in because they are too heavy

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2 In evidence before Scurvy Committee.
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to carry. The only thing we could have there would be Edward's preserved potato, but it is an immense distance to carry it, and it is never thought of because they have never had any disease arising from want of vegetables. Of course they get berries occasionally, but that is not in winter time, and it is usually only in small quantities." The Company's men generally got little or no vegetable food. At York Factory they kept lime juice because sometimes they had to live largely on salt meat. When there was not an ample supply of venison, then only Edward's desiccated potatoes and cranberries were issued, as it was found that scurvy might occur without; but when the fresh meat and fish were ample, the potatoes and cranberries were not given.

The quantities of meat used were large. When Sir John Richardson and Dr. Rae, with a party of English sailors and sappers, wintered at Fort Confidence, on the Great Bear Lake, 1848-49, there were only twenty-five lbs. of flour or barley meal served out to each man during 240 days. The daily rations for all in the Fort were, to quote Dr. Rae's words again: "8 lbs. fresh venison per man, 4 lbs. per woman, 2 lbs. each child; or 4 lbs. half-dried meat for a man, 2 lbs. for a woman, 1 lb. for a child; or when we had fish, 3 large white fish per man, 2 large white fish per woman and 1 per child. The fish ranged, according to my memory, from 3 to 4 lbs. each weighed, as taken out of the water."

Lieutenant Pullen, who left the "Flover" in July, 1849, with thirteen men in two whaleboats, to search for Sir John Franklin east along the coast of North America, wintered with Dr. Rae on Mackenzie River. They had met with stormy weather in the boats, gales, mostly northerly, bearing down heavy ice on them on a lee shore, and they had had to throw overboard most of their provisions to save their lives. Some of the men wintered on the Great Bear Lake and lived entirely on fish, principally herrings, which they caught in nets set under five feet of ice. The others, on Great Slave Lake and at Fort Simpson lived as the Hudson's Bay traders lived, on dried or fresh deer meat and fish, brought into the stations by the Indian hunters. The allowance of flour for an officer was one or two bags per annum, and his guest shared with Dr. Rae the allowance; but the men had none. The rations of meat were as quoted above, 8 lbs. fresh deer or 4 lbs. dried (the dried meat was without bones). The men had nothing else to eat, except when game was to be had, which gave the only variety. In that case two wild geese was a man's daily allowance, or four ducks. The fish for Fort Simpson was brought from the Great Slave Lake in August, buried in the snow and dug out as required. One fish day a week was the rule. In the officers' mess they sometimes had potatoes, but the men had none. Spruce tips were not eaten and no beer was brewed, neither spruce-beer nor any other sort. The only drink was water. Tea was not then issued by the Company and there was very little sent up even to buy, either of tea or sugar. No spirits or wine were issued to men or officers and they had none. At the end

1 To Scurvy Committee.
Rear-Admiral Pullen's evidence, Scurvy Committee. Parliamentary Papers, 1852, L.I.

It is an interesting comment on the later chronic ptoamine theory that the fish was often "rotten" by the spring, "or what is called short; not offensive so far as smell went, still we were obliged to eat them." See also Dr. Redpath's statement in Lancet, November 28, 1901, that African natives eat decomposing meat and do not have scurvy.
of this winter of between eight and nine months, from early October to late June, Lieutenant Pullen's men were all fit, and eager to get back to the coast and carry on. They did so, came back again to Fort Simpson for a second winter, and got home to England in 1851. Lieutenant Pullen himself was the only man who ailed at all, and he did not have scurvy. And he never saw or heard of scurvy during his sojourn on Mackenzie River.

Mr. Campbell, who had been chief trader in a branch of the Mackenzie River for fifteen years, 1837-1852, said he never had vegetables of any kind whatever and sickness was unknown among his people, "except sometimes being weak for want of food." He never saw a case of scurvy during forty years in Hudson's Bay. The Hudson's Bay pemmican, used by their people when travelling, was not commonly made with currants and raisins like the American, but plain, unsweetened. Only when it was wanted specially fine some service-berries were added.

A striking case of the use of fresh meat in extreme conditions is given by the second Grinnell Expedition under Dr. Kane, in 1853-55. When conditions were at their worst, in spring, 1855, and every man was seriously ill with scurvy, their condition went up and down in exact and immediate relation with their casual and irregular supplies of fresh meat. Again, during the first winter when all were affected, Dr. Kane himself was among the worst cases, but in the second winter his health was comparatively good, and he attributes this to his having been the only man on board who would eat the rats with which the ship was infested.

Then there is the interesting case of nineteen people who were cut off from the American ship "Polaris" and lived on the ice-floe for six and a half months, in 1872-73, having already spent a winter on board ship in lat. 81°. They had with them some bags of bread, a quantity of pemmican, which would be the American sort with fruit in it, and a small quantity of chocolate, and they killed seals which they ate uncooked. The party included two Esquimaux women and five children. They were picked up in May by a Scots sealer, all well.

In his Presidential Address to the Royal Geographical Society in 1852, Sir Roderick Murchison speaks of Russian sailors on Spitzbergen, who had lived on game for more than six years, and three out of four were brought home in perfect health.

Later, there is the case of Mr. Leigh-Smith's men on Franz-Josef Land, who when their vessel, the "Eira," was sunk, lived in health on fresh bear and walrus meat. Dr. Neale entitles his account of that experience "How to Avoid Scurvy in Arctic Regions," but as he does not tell how to ensure that there shall be bears and walruses to live on, he makes no new discovery. The regions

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1 Scurvy Committee's Report, Appendix No. 28.
2 "Second Grinnell Expedition," Dr. E. K. Kane, 1858.
3 Of fresh meat, seal was believed to be more antiscorbutic than deer-meat; Dr. Kane believed in walrus-meat. McClintock says that white whale was greatly prized by the Greenlanders, and speaks of the pickled skin of the black whale as "a famous antiscorbutic."
6 Practitioner, 1890, Ivi 686.
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of the western Arctic have so much less open water that they have very much less game in winter than is met in the eastern Arctic.

Mr. Jackson has a story of six Russian priests who sojourned at Habarova, in Arctic Russia, a few years before his own visit there in 1893. Their vows bound them to abstain from eating meat, and by the end of the second winter in the frozen land all had died of scurvy, while their servant, a young boy who had lived on reindeer, was in good health. Mr. Jackson himself and his eight companions of the Jackson-Harmsworth expedition to Franz-Josef Land in 1894, added fresh bear meat to an otherwise very full and complete provisioning, and had not a single day's illness in their three years.

It appears that in such cases as that quoted above, of our soldiers in the Kaffir campaign, the abundant supply of fresh meat does not give the amount of protection it should. This is probably due to the unvarying stew of the British Army. Probably about 100 per cent of the meat meals served in the Army abroad are cooked for two or three hours, and the meat and the vegetables cooked with it are thus robbed of one of their most important properties.

The staff of life, then, seems to be the one type of food that will not alone sustain life, and in comparing the history of the 1875 ships with that of the earlier ones, the occurrence of game is second in importance only to that of vegetables. But we do not find that the earlier ships had more fresh meat on the whole than had the "Alert" and "Discovery." Dr. Armstrong writes, of "Investigator": "In the autumn of 1850 we were fortunate in procuring some musk-oxen, the flesh of which was issued in lieu of salt beef, at the rate of one pound per man each week, and occasionally three times a fortnight, for a few months. In the following summer we were equally fortunate in procuring game, consisting of wild ducks, geese and ptarmigan, which for about three weeks afforded us a pound of fresh meat weekly. Throughout the winter of 1851-52, owing to the circumstance of meeting with reindeer, we were enabled to issue a pound of fresh meat three times a fortnight, the allowance being subject to occasional interruptions, and birds were procured in the summer as before. For several months of the third winter we were also enabled to continue the supply of reindeer, and occasionally the supply was continued in the spring." That is, in the first winter, the time comparable with "Alert" and "Discovery's" winter, they had one pound of fresh meat a week, or sometimes three pounds in two weeks. This is more than "Alert's" fourteen meals in ten months; but it is much less than "Discovery's" total 18,000 pounds of game, or 800 pounds of fresh meat issued per month, i.e., 15 pounds per head per month, a supply equalled by few previous expeditions.

Herbs and Vegetables available.—On most of the ships attempts were made to grow mustard and cress, but with very indifferent success. Some

1 "The Great Frozen Land," F. G. Jackson, 1895.
2 "Naval Hygiene and Scurvy."
was grown on board "Investigator," but not much. On board "Alert" and "Discovery" there was never enough produced for a general ration, and only the officers had a little occasionally.

On the "Investigator," "In the summer of 1852, for a period of nearly three weeks, we were able to procure limited supplies of sorrel (\textit{Rumex acetosella}) and scurvy-grass (\textit{Cochlearia officinalis}), which were daily issued in variable quantities of a few ounces. This was the only fresh vegetable food that we ever obtained." The later expedition also got sorrel in summer, but by that time of course they already had scurvy rampant.

\textit{Beer supplied.}—There was a small difference in the beer used by the two expeditions, which, had it been brewed from the air-dried malt of Captain Cook's time, might have told in favour of the earlier ship. Both carried Allsopp's Burton ale in casks, which lasted perhaps through the first winter; but in the "Investigator" small beer was also brewed on board and issued occasionally. Had there been any antiscorbutic value in either of these beers, the ship that had the fresh brew would presumably have been at an advantage; but malt was by that time "high-dried," so there was probably none.\footnote{\textit{Naval Hygiene and Scurvy.}} The beer consumed on the "Alert" was not more than half-a-pint per head, two or three times a week, and if rather more was used by the "Investigator's" crew, any gain to the latter would certainly not balance the disadvantage they were under by their larger consumption of rum. In any case, the quantities used were so small that the variation between the two may safely be disregarded.

Questions of conditions on board Nares' ships, work and exercise, ordinary diet, fresh meat and vegetable supplies, and many others were considered in great detail by the Scurvy Committee. Several Arctic leaders concluded that in the absence of any other apparent reason, the harder work Nares' sledge-parties had had than most, though not all of their predecessors, must account for their extraordinary misfortune and Sir George Nares himself was of this belief.\footnote{Harden and Zilva, \textit{Journal of the Institute of Brewing}, 1918, vol. xxiv, p. 107.} Many expressed their continued opinion that it was unaccountable. The Committee reported that it was due to the failure of the sledge-parties to take lime juice; but the impression remained which was afterwards expressed by Admiral Richards.\footnote{\textit{Introduction to Nares, "A Voyage to Polar Seas."}}

"Much stress has naturally been laid on the superior equipment of this Expedition and on the great advantages it possessed over previous ones; but when we come to analyse those advantages they are, more apparent than real. Doubtless no ships could have been more efficiently

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equipped or better provisioned, yet in this respect there could scarcely have been any appreciable difference between them and the numerous expeditions which had been employed previously in the search for Franklin. In all their arrangements the Government were actuated by one principle—efficiency and comfort—regardless of expense. Yet we find the travelling parties of the present Expedition attacked by malignant scurvy which almost prostrated them after one winter in the ice, though happily the mortality exceeded that of no former expedition. If we turn to the records of the condition of crews of Collinson's and McClure's ships after three and four winters passed in a much lower latitude we find an absence of any severe case of the same disease, and so in other voyages of shorter duration... These are significant facts, the causes of which have hitherto been past man's finding out."

The discussion of the Commission might almost be summarized in words of John Woodall, written in 1617, "Truly, the causes of this disease are so infinite and unsearchable as they farre pass my capacity to search them all out. ... Some charge Bisket as a cause of the scurvy but I am not of their opinion; some say inordinate watchings are the cause thereof; some say extreme labour wanting due nourishment; some also affirm care and griece to be some cause thereof; others affirm the very heat of the aire, resolving the spirits; but what shall I amplifie further? for it is also true that they which have all the helps that can be had for mony, and take as much care as men can devise are even by the evil disposition of the aire, and the course of nature, strung with a scurvie; yea and die thereof at sea and land both."

*(To be continued.)*