MAN'S PRIME REQUISITE—FOOD

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Of the many things which man must provide for himself, food and water are prime requisites and always have been. Neither clothing, shelter, association with fellow man nor the multitude of other requirements which we variously classify as necessities or luxuries in accord with our station or present circumstance, can claim the primal and constant position in our happiness and survival as does food. Nor does man occupy a unique position in this regard, as a moment of reflection on the requirements and habits of members at all levels of the animal and vegetable kingdoms will make clear. The tree will send its roots to great lengths and through tremendous obstacles to obtain its required nutrients. Just so will an insect, such as the ant, provide fascinating copy for the writer who describes its efforts and prodigious feats in procuring its food.

A man must eat. And this he must do with reasonable frequency, for nature has not equipped him to live otherwise. He cannot, like some insects, gorge himself during a period of plenty and then after a long nap transform himself into a self-sufficient state and flutter gracefully through his remaining years without the slightest concern about such base endeavors as eating. No, he cannot even do as the huge bear after his final autumn banquet—turn in for a long winter nap and there remain oblivious to the world until climatic conditions again stock his larder.

A man must eat. We are told of instances where he has survived for two months without food, but usually the hunger from a few days of abstinence will drive a person into a wild and dangerous mood. Many amazing, and often gruesome, tales have been recounted of the extremes to which a man shipwrecked, lost in a blizzard, or otherwise stranded in an area barren of food will resort. Under such circumstances, he is little concerned about flavor, sanitation, or source of supply.

The acts of the hungry individual are magnified in a family, community, or nation bereft of an adequate food supply as has been shown by historians describing both ancient and modern events. The Bible is replete with examples of the instability among peoples who experienced food shortages. Abraham and his family were driven from the Negeb, to which they had migrated from Haran, by hunger. "Now there came a famine in the land; and because the famine was so severe in the land, Abram went down to Egypt to reside there."

In more recent times and very close geographically, another exam-

ple of instability associated with a food problem has been unfolded to us by students of the Cliff Dwellers who lived in what is now our Mesa Verde National Park in southwestern Colorado. Here was a most fascinating social group who had developed a system of living quite unique in many ways and who apparently flourished for a period of at least two hundred years from the eleventh century until the late 1200's, at which time they disappeared suddenly and completely. It is believed that starvation was an important contributing factor and was occasioned by the great drought of 1276 to 1298, a climatic catastrophe revealed by examination of the tree growth rings in that area.

Old English history is also filled with the importance of food in the development of that nation. In a book by Prentice entitled *Hunger and History,* it is stated that in the eleventh and twelfth centuries in England, famine is recorded every fourteen years on the average, and the people suffered twenty years of famine in two hundred years. It is interesting to note a summary of some of the famines which occurred in Europe during the thirteenth century. I shall quote a few of these from Prentice's book.

The year 1200, Ireland, a cold, foodless year.

1203: England, a great mortality and famine from long rains.

1203: Ireland, a great famine, so that the priests ate flesh meat in Lent.

1209: England, famine from a rainy summer and severe winter.

1224: England, a very dry winter and bad seed time, whence followed a great famine.

1235. England, famine and plague. 20,000 persons die in London. People eat horse flesh, bark of trees, grass, and so forth.

And so goes the record through the whole century. In some cases, food shortages have been aggravated by political situations. For example, in 1845, the year of the calamitous Irish famine, the potato crop was almost entirely ruined by disease. This was a tremendous disaster to the Irish, since half their population depended almost entirely on the potato for sustenance, and the other half depended at least in part upon this same commodity. As a result of a strong agricultural lobby, laws had been passed which were called the Corn Laws. These precluded the importation of any grain, commonly referred to as corn, so that it was impossible under them to import grains into Ireland. Tens of thousands of people are reported to have perished from this famine, and, because of the seriousness of it, the Corn Laws were repealed to permit the importation into Ireland of other foodstuffs. However, there resulted from the famine almost a mass migration to the United States and a consequent substantial fall in the population of Ireland.

Food has continued to be of tremendous importance in the politics of our modern world. I am sure that all of you will recall the slogan which was so widely used during the Second World War—"Food will win the war and write the peace." And today our Congress debates the pros and cons of sending large shipments of wheat to India to avert serious famine among their peoples and perhaps incidentally to win some political advantages.

A remarkable change has been brought about in our way of life as a result of changes in our methods

of acquiring food. Some of our earliest forebears lived on roots, nuts, and berries, under which circumstance it has been estimated the whole earth could support but a few hundred thousand souls. There were also the "cliff pushers" who stampeded large animals over high cliffs to their death or such serious injury that they could not escape their hungry pursuers.

With the invention of the spear and later the bow and arrow, man was well adjusted to an animal diet. This early man devoted a major portion of his time in the satisfaction of his food requirements entirely from natural sources by hunting animals, collecting herbs, fruits, and nuts, stealing eggs from the nests of birds, or by fishing. Contrast that situation with today when an increasingly small proportion of man's time is devoted to the actual gathering and preparation of food. Quite obviously, it would be impossible to support a large population with the gregarious instinct so active as in modern man when it was necessary to depend on natural sources for food. Today essentially all our foods are produced under cultivation. This is true even in the case of some fish, which are being cultivated in increasing amounts on fish farms and by the stocking of public streams and ponds. Oysters have been cultivated for many years in the Chesapeake Bay.

Certainly one of the remarkable changes in man's way of life came with his change from a hunter or migratory being to a more or less fixed creature who had started the development of agriculture. This purposeful rearing of plants and animals came during the latter part of the stone age and was well under way by 5000-6000 B.C. In general, the ancient nations which have survived down through the ages have been those located in fertile areas where agriculture yielded regular and abundant crops. It was hardly an accident that civilization prospered in the valleys of the Tigris and Euphrates rivers, for this indeed was a rich area, as was all of the "Fertile Crescent," which extended north and west from that cradle of civilization. The delta of the Nile is another area of rich agricultural land, and here, again, we find a nation which has existed from ancient times.

Many of the wars of history have been waged for the principal purpose of acquiring food. Even in the great Second World War, the strong plea of Germany was for *Lebensraum*. *Lebensraum* for what? Certainly not necessarily for her industries but more for larger agricultural areas where food might be produced to support the "superior race" which would live in her existing cities. Italy, too, sought to expand into Ethiopia to derive larger agricultural production, and Japan into Manchuria. One might even suspect that England had some such notion as this during her early imperialistic development. Not always has food been the motivating force which has brought about a war, but, as Voltaire has said, "The fate of a nation often depends upon the digestion of the minister."

The lack of food or the glut of food has determined the course of battles. One interesting story is that told of the battle for Leipzig, prior to which Napoleon gorged on a shoulder of mutton stuffed with

onions. He became sluggish and incapable of clear-minded and vigorous action. In consequence of this, he made tactical errors, and the battle went against him. It has been suggested by some that the large monument erected on the outskirts of Leipzig, which tells how good were the Germans on that glorious day, might more appropriately have consisted of a monument topped with a victorious leg of mutton.

Along with the change to an agricultural world in which most of our foods are produced under cultivation has come recognition of the necessity of developing methods of preservation of foods. Food must be available to men twelve months of the year and must be transportable from areas of abundant production to those less favored by climatic conditions or soils. In some instances, of course, nature herself has provided the means of preservation in certain commodities, such as the cereal grains, edible seeds, and nuts, which have undergone a natural drying and which we may classify as stable foods.

Cereal grains, in particular, have very excellent stability; in fact, some have been found in the tomb of King Tut which are said to have been in excellent condition many hundreds of years after harvest. Perhaps even more dramatic was the discovery of barley, millet, peas, and beans which had been put away by the Swiss Lake Dwellers 5000 to 6000 B.C. This finding in 1854 along the shores of Lake Zurich followed a very dry period when the lake level had fallen so low that the early dwellings became visible and led to extensive exploration.

Tubers and some fruits which mature late in the season or which undergo natural drying may be said to have intermediate stability. For example, potatoes; late varieties of apples; and those tropical fruits, such as the dates and figs, which desiccate naturally, have this intermediate stability. They, too, have been very important items of diet, especially in the case of the Irish potato. The fig and date as important items of diet go back to ancient times; however, a great majority of our fruits and vegetables, milk, eggs, and the flesh of animals are very perishable and, therefore, must be used almost immediately upon harvest unless in some manner preserved.

In one sense the living animal may be in itself looked upon as a means of food preservation. Many species which feed upon highly perishable vegetation during the warm season may be used in man's diet long after the winter season has killed vegetable foods. Moreover, some agriculturists have advocated the use of the "livestock cushion" whereby animals may be used to relieve surplus production of crops one season and tide over a food deficiency on a subsequent season.

Unfortunately, many of the foods which fall into the stable classification are lacking in some of the important nutritive values, and this frequently has had an impact on the health of peoples who have been limited in their diet to such materials. One classic example is that of the early sailors who had to spend many weeks at sea once they set forth from port; since in those days there was no such thing as refrigeration

or canned foods, of necessity ship galleys were stocked only with those foods which were stable. Fresh fruits ordinarily were not included in the diet; the almost invariable result was scurvy. Today every enlightened person knows the cause of scurvy; he knows that it is prevented by Vitamin C which, of course, is present in a great variety of fruit and vegetable materials, particularly in citrus fruits.

Probably the first method of preservation of foods was that of dehydration, which in fact is of unknown antiquity. As I have already mentioned, natural sun-drying preserved many fruits, especially those of high sugar content such as dates and figs. Generally those fruits grew naturally in areas where weather conditions were favorable to desiccation. At a later date, it was found that milk could be partially preserved by converting it to butter and cheese, which process involves partial dehydration. Even dried milk, which we think of certainly as a modern invention, was made by the Tartars according to an account of Marco Polo dating from 1289. It is doubtful that their product could hold its place in competition with present-day products.

Meat, and possibly fish, was dried by exposure to air, especially in regions of dry climate. The American Indians, particularly the Western tribes, are known to have preserved certain foods by drying. For example, they dried venison into a product known as jerky, and they also dried olives which in this form remained edible and highly nutritious, if not palatable, for a long period of time. The Indians of Peru dried potatoes by freezing and exposure to the sun.

Later than dehydration came the method of preservation involving the use of salt, which in reality is primarily a process of drying, the salt being used for drawing out the moisture of the fish or meat being so preserved. Smoking of fish and meat also was employed to give a distinctive flavor and to provide a measure of preservation through the action of the cresols and formaldehyde in the smoke.

Spices have been tremendously important for many years, and, in fact, the demand for spices was a factor which led to Columbus' historic expedition, which so widely miscarried from its original objective, but, as a somewhat important by-product, led to the discovery of the Americas. Spices had a two-fold use in the early days. First, as a mask for the bad odors and tastes which resulted from putrefaction of the food then commonly available in Europe. In other words, spices made it possible for a human being to consume food which today would be considered wholly inedible. They had a second purpose: the essential oils which retard spoilage caused by microorganisms acted as a partial preservative.

Another type of preservation which dates back to antiquity is that of freezing. We are inclined to think of freezing as a modern and recent method of food preservation, and indeed it is as we do it today. However, freezing, like dehydration, was one of those natural processes which occurred in certain climates and which was taken advantage of by individuals who consumed animals and fish in early times. Artificial preservation by above-freezing cool storage must have been an early

practice, for it is reported that the Romans transported ice and snow from the northern and mountainous regions for this purpose. Significant also is the statement that the first export from New England to the West Indies was a shipload of ice.

It would be remiss indeed to fail to refer to fermentation as an early means of preservation. For example, wine is a preserved form of fruit juice, and the preservation of cabbage by soaking in sour wine or vinegar was a pre-Christian practice. Sauerkraut, the fermented and thereby preserved derivative of cabbage, was popular in Europe over 400 years ago.

Modern methods of food preservation originated with the development of canning. This process dates back to the year 1795 when France was not only in the throes of a revolution but at the same time at war with several hostile European nations. The problem of insuring adequate and suitable food supplies for the army and navy, as well as the civilian population, had become very acute. Disease was rampant among the French armed forces, and it became clear to the French Directory, the five-man governing board which ruled the country at that time, that some new means of preserving food would have to be devised. Consequently, a prize of 12,000 francs was offered by the Directory to any person who would develop a successful means for preserving a wide variety of foods. Appert, an obscure Parisian confectioner, entered the competition and was awarded the prize in 1809. Appert also published the first treatise on canning in 1810. The first English translation appeared the following year.

At the time of Appert's work, the causes of food spoilage were not known, and, in fact, were only partially disclosed a half century later by the classical researches of another Frenchman, Louis Pasteur. Today we classify the factors involved in food spoilage in three major categories: first, microbiological, which includes the yeasts, molds, and bacteria that bring about souring, development of bad flavor and odor, loss of color, and other types of spoilage in the food product. Some of these are purely aesthetic factors, but, in others, definite toxic materials develop, leading to such disorders as those commonly called food poisoning or to the fatal botulism. The second classification may be called macrobiological. This is the type of spoilage caused by infestation with insects or rodents. The third class is chemical and involves such changes as those brought about by the naturally occurring enzymes which, when uninhibited, may cause losses of vitamins and undesirable changes in color, odor, or texture of the foodstuff. Without being acquainted with these factors nor realizing their significance, Appert overcame in large measure all three by his invention. In his work, Appert used wide-mouthed, glass bottles which he filled with the food, carefully corked and heated in boiling water. In his early text, he described canning procedures for more than fifty foods and set forth such postulates as careful sealing, utter cleanliness and sanitation in operations, use of highest quality raw materials, and adequate heating, all of which remain valid in modern canning practice.

It was not until 1810 that Peter Durand, an Englishman, conceived and patented the idea of using vessels not only of glass, but of pottery, tin, and other metals. This was the forerunner of the modern canning industry, which has grown to such huge size today. It is believed that William Underwood, who had come to America in 1817, started the first American canning operations in Boston in 1819 using Appert's procedure. However, it was not until 1840 that tin containers came into widespread use. The Spanish-American War, and particularly the World War of 1914-1918, also exerted significant expanding influences on the canning industry. Consequently, in the United States today the industry is composed of about 3,500 canning establishments which normally produce more than three hundred different canned foods. We have become so accustomed to having available seasonal fruits and vegetables at all times of the year, canned meats, milk, and specialty products of wide variety that we overlook the enormity of this development in food preservation and its impact on our society.

Although several persons have contributed to the development of frozen foods, it is natural to look to Clarence Birdseye as the man who, perhaps, contributed more to the commercial application of freezing preservation than any other single person. He early recognized the importance of using only the highest quality of raw materials in the preparation of f r o z e n products. Freezing has some advantages over canning with certain foodstuffs, and with the widespread distribution of freezing equipment and the development of household frozen-food units and community locker plants, it is now possible for nearly every housewife to take advantage of this type of preserved food. Generally speaking, the advantages of frozen foods lie in their more natural flavor and color. The disadvantage lies in the necessity for freezing equipment in which to store the products.

It is important that we have more than one method for preserving large quantities of foodstuffs; this was apparent during World War II when we experienced severe shortages of steel and tin because these metals were essential for other military uses. Moreover, we were confronted with the problem of shipping tremendous quantities of foodstuffs to our armed forces located all over the world. This requirement led to a remarkable development in what is perhaps the oldest of all methods of food preservation, dehydration. Modest amounts of dehydrated eggs had been used in this country in recent years, especially by the baking trade which consumed an average of about ten million pounds a year. Wartime requirements stepped up the production of dehydrated eggs to well over 400 million pounds each year. The significance of this in terms of shell eggs may be comprehended when it is noted that one pound of the dehydrated product is equivalent to three dozen eggs.

Production of powdered skim and whole milk and ice cream powders also reached new highs. Great numbers of fruit and vegetable dehydration plants were built almost overnight, and large quantities of

dehydrated fruits and potatoes, carrots, cabbage, and certain other vegetables were sent overseas for use in lend-lease and for the armed forces. Unfortunately, many of these products were not of the best quality when they reached the consumer, and because of inadequate knowledge in the handling of such foods, the mess sergeants seldom produced therefrom highly palatable meals. However, research led to remarkable advances in dehydration during the war, and it is possible today to produce some very satisfactory dehydrated products; so a third important commercial method of food preservation is available. This method may be of special significance in the stockpiling of foodstuffs in preparation for possible food shortages or for military needs in any part of the world where long-time storability is important.

The processing and preservation of foods has become so important to our present-day society that nearly four-fifths of all the food consumed today has been processed by one means or another. The food-processing industry is the largest of all the manufacturing industries, outranking considerably even our great automobile industry. With this growth has come the development of a specialized field of learning which we call food technology.

What is food technology? Let us say that it is the application of such sciences as chemistry, bacteriology, and engineering in the conversion of the raw materials of the field and the sea to the finished food which comes to our tables. It covers such diverse operations as canning, freezing, baking, cereal milling, cheese making, meat processing, beverage manufacturing, oil-seed processing, and candy making. The food technologist sets forth as important objectives in the development of food products the best possible palatability, high nutritive value, good stability, as well as interesting variety and novelty, convenience in using, and reasonable prices. How much progress has he made in the achievement of these objectives — just spend an hour in your local super-market and you can judge for yourself!

But what about the future—what may we anticipate in our foods of tomorrow? What direction are some of the very recent developments taking?

First, a few words about concentrates. Very likely every one in the audience has used frozen orange concentrate—that remarkable development which in two or three years has grown to an annual production of about 250,000,000 pounds of frozen citrus concentrates. This is equivalent to a billion pounds of regular juice. Similar products for grape juice, lemonade, coffee, and tomato juice are coming on the market and others are in the experimental stage. Apple concentrates have been produced experimentally which are so true to the original flavor that a person acquainted with the characteristic flavors of different varieties readily can tell what apples were used in producing a particular concentrate. The secret for several of these products lies in concentration by vacuum at about room temperature followed by a partial dilution with fresh juice and then freezing without subjection to any heat treat-

ment. So far a completely satisfactory frozen milk concentrate has not been produced, but a three-to-one concentrate in liquid form has now been introduced on the market in several cities.

Complete removal of water from certain products is finding its place. Some of the soluble powdered coffees on the market are obtained by drying the frozen coffee extracts under high vacuum. The same procedure has been studied in an effort to obtain high-quality orange juice and milk powders. Dehydrated potatoes in the form of granules which reconstitute quickly to mashed potato are available. Partially dehydrated and then frozen apple slices, a product called dehydrofrozen apples, retains the desirable characteristics of dried and frozen apples without the disadvantages of either. Commercial pie bakers and Army and Navy supply officers are much interested because of the important saving in bulk, weight, and container materials coupled with convenience and fresh-apple quality. We may expect increasing amounts of our food to reach us in these convenient concentrated forms in the future.

Advances are being made by the canning industry in its continued effort to produce canned foods with better color, texture, and fresh product flavor. Much of this development is directed toward methods of achieving sterilization with a minimum application of heat. In this quest one interesting and very recent approach has been the trial of antibiotics in the canned product. The studies are purely exploratory up to the present time and the results somewhat contradictory. However, under certain conditions the addition of as little as 10 parts per million of the antibiotic subtilin followed by a very mild heat treatment definitely prevented spoilage of canned foods which in the absence of the subtilin spoiled very quickly. With the increasing store of antibiotic materials which are becoming available it is a hopeful possibility that some will be found which will be useful food preservatives.

The development of rancidity and off-flavors in frying fats, shortenings, and salad oils, and the staling of crackers, cookies, potato chips, and similar fat-containing foods is becoming less and less a problem with the development of more potent antioxidants which are without undesirable tastes or flavors and definitely non-toxic. Not only has the prevention of rancidity esthetic value but also it may have significance from a nutritional standpoint.

Possibly the most dramatic investigations in the area of food preservation are the use of X-rays and cathode rays. These studies are presently being carried on in both commercial and university research laboratories. The notable accomplishments of nuclear physicists and electrophysicists in recent years have given us such potent high-voltage generators or particle accelerators as the Van de Graf generator, cyclotron, capacitron, and betatron. Foods of various kinds have been exposed to X-rays produced by high voltage electrons and by the cathode rays themselves. The exposures have been in the nature of fairly long continuous irradiation and also of very short pulses of extremely high intensity. In many of the studies three million volt electrons have been used with complete destruction of all con-

taminating microorganisms. Although the X-rays have been found capable of destroying micro-organisms they are too slow, requiring 10-20 minutes for spore formers. With the cathode rays but a few seconds are required.

It is stated that enzymes are inactivated by the cathode rays; thus two of the main causes of food deterioration are removed at once by this treatment. Of course, the foods must be protected from recontamination by sealing them in glass, metal containers, or plastic bags before irradiation. Such products are reported to keep remarkably well even at room temperature for many months, and in a report in the popular press it is claimed that raw hamburger has retained its fresh red color and flavor for four years after treatment. Also in a popular press report it is claimed that a commercial plant will go into operation next year with a capacity to process up to 50,000,000 pounds of food per year at a cost of about one-half cent per pound. However, there is much research yet to be done before this proposed process of food preservation can be looked upon as safe and effective.

Strange results have been observed such as the very bad taste which developed in milk when exposed to cathode rays, the bleaching of color in skin and flesh, and development of off-taste in raisins but not in prunes, and the severe discoloration of some meats exposed at room temperature, whereas they retained their natural color if refrigerated first. Moreover, studies have shown losses of perhaps serious consequence in carotene and riboflavin and to a lesser extent in other vitamins. Little is known about possible changes in proteins and fats which may affect their nutritive value or possibly even produce toxic substances. Nevertheless this promises to be a powerful tool in fashioning our foods of tomorrow and may prove useful in preserving other perishable products, from antitoxins to roses.

There are numerous other developments on the food horizon including new methods of processing, new formulations, and even synthetic foods. Some of these will prove valueless, uneconomical, or for some other reason will never see the light of day. But others will reach our tables next month or next year to bring us advances in nutrition, convenience, and palatability, and thereby play their part in our developing way of life.

"The great motivating force of the human race is the empty stomach."