CHAPTER I

INTRODUCTORY AND HISTORICAL

THE consumption of food, apart from the question of errors of quantity, may be a source of ill-health in a number of ways, the following being the most important:

(*a*) The food may be inherently poisonous. Noxious plants are well known, while animals, the flesh of which is poisonous, either always or at special times, are not uncommon.

(*b*) The food may be a cause of disease because it acts as a vehicle for the transmission of disease-producing bodies—of plant origin (such as ergot), of animal origin (such as the animal parasites), or of bacterial origin (anthrax, tubercle bacillus, etc.)—which are introduced with the food and which are directly derived from diseased plants or animals.

(*c*) The food may originate from healthy sources but subsequently become contaminated with bacteria pathogenic to man. The food may remain not visibly altered or may have undergone extensive decomposition changes.

(*d*) The food may be prejudicial because it has become admixed with bodies of a chemical nature which exert a harmful action upon the animal organism. Examples of such additions are chemicals added as food preservatives and poisonous metals derived from food containers or accidental admixture.

Admixture of food substitutes which irritate the alimentary tract to the extent of producing symptoms may possibly be grouped under this heading.

(*e*) The food may be so treated in preparation that valuable and essential substances have been removed, causing the so-called deficiency diseases.

(*f*) The food itself may be sound and uninfected with either harmful bacteria, parasites or chemicals and yet may originate illness in certain individuals owing to the existence of a special abnormal sensitiveness (idiosyncrasy conditions).

This is an extensive list and using the terms food poisoning

and food infections in their broadest meaning all might be so included. The title bacterial food infections excludes consideration of the animal parasites transmitted through food. Also the diseases induced by the removal of essential food constituents are negative rather than active in their origin and cannot be considered to come properly within the scope of the present volume. These deficiency diseases, as they are frequently called, include beri-beri, scurvy and probably pellagra, and are due to the diet being insufficient in certain essential substances known as vitamines, which are contained in the natural foodstuffs, but which may be removed in the course of preparation. They will not be further considered.

Common usage has given to the title of this volume a more restricted meaning and while this interpretation is one which cannot be defended as either entirely accurate or strictly scientific, yet it provides a convenient delimitation of an otherwise very scattered and far-embracing subject.

The infections induced in man by the consumption of meat from animals definitely ill with bacterial infections, such as anthrax or tuberculosis, and in which the like disease is set up in the persons infected, are true examples of bacterial food infections, but as they are fully dealt with in general and special textbooks they are only given comparatively brief consideration.

The cases in which the food merely acts as a vehicle for the transmission of the bacteria of well-known infectious diseases are conditions not generally understood when the above expressions are used although it is obviously impossible to set up a sharp scientific line of demarcation. A brief general discussion is all that is required therefore in explanation of these infections (Chapter II).

The remaining conditions are those which are usually specially understood by the terms food poisoning and food infections, and these are treated in considerable detail in subsequent chapters. It will be seen that they comprise:

1. Inherently poisonous plants and animals.
2. Foods only poisonous because of abnormal reactions of the individual.

3. Bacterial food infections causing more or less acute symptoms of poisoning.

4. Food poisoning cases from admixture with harmful chemical substances.

While the group due to admixture of chemicals is of great importance, the majority of the outbreaks and cases which are recognized as cases of food poisoning are undoubtedly bacterial in nature, and it is to this branch of the subject therefore that attention will mainly be given. The symptoms caused are due to the food being infected with bacteria which produce toxic products, either before or after ingestion, to which the symptoms are due. Under this heading is included those cases in which the food has undergone bacterial changes outside the body, of the nature of putrefaction, and those in which the specific bacteria have produced little or no visible changes, but exert their most characteristic activities after consumption.

Food poisoning conditions are frequently classified according to the vehicle of infection, those due to ordinary meat, shellfish, milk, cheese, ice-cream, sausages, fish, potatoes, etc., being separately described as if they had a separate and special causation. A few of these show special peculiarities with possibly a separate and peculiar etiology and so are more conveniently considered from this point of view, but apart from these such a classification is a most unscientific one and has nothing to recommend it. The vehicle of infection has little or nothing to do with the type of infection and the only scientific classification possible is one based upon the infecting agent.

The extent to which individuals are prejudicially infected through the agency of food cannot be estimated even approximately. The attacks may be so variable in severity, ranging from a trifling gastro-intestinal disturbance to severe symptoms dangerous to life itself and sometimes forfeiting it, may be so obscure and insidious in origin and so little anybody's business to investigate and record that it is quite impossible to statistically estimate their frequency. Most persons are attacked, at one time or another, with symptoms pointing with reasonable certainty to a derange-

ment of the alimentary tract set up by some article of food eaten shortly before the illness. When these attacks involve a number of persons there is more likelihood of their being recognized as a food poisoning outbreak, but even the majority of these pass unnoticed in the scientific journals or in the daily press.

All that can be said is that attacks of illness from specific contamination of the food are undoubtedly of considerable frequency and that even extensive outbreaks are probably far more prevalent than the published records of them would lead anyone to believe.

Short historical account.

Food poisoning must be as old as man himself. In the days of his dawning intelligence when driven by hunger or the delights of the eye to experiment with strange foods he no doubt learnt by bitter practical lessons that death and illness lurked in many foods and by painful experience acquired a knowledge of good and evil as it applies to food. In later times with more detailed knowledge as to foods death still lurked in the pot but it was frequently enough a deliberate death induced by malice, and the very widespread institution in ancient historical times and in the Middle Ages of official food tasters to king and princeling is a witness of the prevalence of the practice of wilful food poisoning. On the other hand in an age when sudden death was always mysterious and suspect, food was no doubt frequently considered to be poisoned when it was not and death was due to other causes. Over-indulgence in food was probably far more frequently a cause of death than deliberate poisoning and an instance such as the death of Henry I from lampreys was more likely to be due to the surfeit of these fishes to which it is ascribed in the history books than to any poisonous qualities inherent in the lampreys, although it is a well-recognized fact that under certain conditions lampreys exhibit poisonous properties.

"Death in the pot" still exists although man has catalogued the poisonous plants and animals, scheduled and restricted

the sale of poisons and made gluttony unfashionable and an offence against taste. Now it takes other forms in large part due to the greed of man and his desire to acquire riches regardless of health considerations. Food is deliberately sophisticated, not in a spirit of vengeance but in one of greed or merely of callousness. Preservatives are sometimes necessary but are often added to conserve that which has become unfit or to keep in saleable condition for long periods what lack of cleanliness in preparation has imperilled. Animals are slaughtered "to save their lives," and to be sold as killed meat fit for food, while diseased meat is washed, doctored and disguised to take its place and obtain its price with the fresh and pure. Strict cleanliness in the preparation of all foods is not enforced and frequently is impossible under many of the prevailing conditions, in part because knowledge does not illumine the business and in part because cleanliness costs a little more. These are the forms that "death in the pot" takes to-day.

Many of the classical authors, such as Hippocrates, Horace and Ovid, refer to mushroom poisoning and some mention other poisonous foods. That food adulteration was practised in early times is clear from the importance given to it in many early enactments and the particulars mentioned by early writers. Wynter Blythe (*Foods, their Composition and Analysis*, 1903) quotes a number of interesting instances in which food was adulterated in Roman, Grecian and early English times.

The early conceptions of food poisoning were purely chemical in nature and this without invoking bacterial action upon the food to produce the chemical poisons. Albert von Haller was apparently the first to make any scientific studies upon the effects of putrid materials upon animals. He found that the injection of watery extracts of putrefying meat into the veins of various animals frequently produced death, while Gaspard in the early part of the nineteenth century carried on similar experiments.

In 1820 and 1822, Kerner published his papers upon poisonous sausages, ascribing the poisonous properties to a compound of sebasic acid and a volatile principle. We now

know that these outbreaks were cases of botulism and due to a bacillus.

Later conceptions of food poisoning, and particularly of meat poisoning, were chiefly based upon the supposed relationship of the poisonous element to putrefactive decomposition of the food, and very numerous investigations were made along this line of inquiry.

Panum, in 1856, appears to have been the first to demonstrate that the poisonous qualities exhibited by putrid flesh were chemical in nature and not destroyed by boiling. Bergmann and Schmiedeberg, in 1868, obtained a highly toxic substance which they called "sepsin" from putrid yeast and from decomposing blood. After this discovery, other allied toxic bodies were discovered and extensively studied, and the whole group of basic substances with alkaloid characters were called *ptomaines* by Selmi. Selmi, however, did not himself succeed in isolating any of the putrefactive alkaloids, all his experiments being made with extracts, and Nencki, in 1876, was the first to isolate any of these bodies. Brieger (1882 to 1888) isolated and investigated a number of ptomaines.

Cadaverine was the first putrefactive alkaloid prepared by synthetic methods. This was done by Ladenburg in 1883, who determined its formula as pentamethylenediamine. Vaughan played an important part in the development of this side of the subject, and in 1884 isolated from cheese, which had caused poisonous symptoms, the body tyrotoxicon, a substance closely allied to the ptomaines.

The ptomaines, being bodies highly toxic to animals (when injected) and being obtained from putrefying meat, were at one time held to supply the cause and explanation of most, if not of all, cases of food poisoning and illness, and these outbreaks became fairly generally known, especially in this country, as cases of ptomaine poisoning. Indeed, at the present time, not only in popular estimation, but even amongst medical men and in scientific textbooks, this term is still largely retained, although, as will be shown later, there is no justification for its continued use.

It will be explained in Chapter VII that ptomaines differ

essentially from toxins in that the former are non-specific, while the latter are specific in that each is an intimate product of the bacterium which produces it.

The great strides now being made in Biological Chemistry have yielded much information as to the composition of the protein molecule and the different substances which result from its decomposition, and also as to how far these products are harmful and a possible cause of food poisoning.

While the ptomaine hypothesis largely held the field as the correct explanation of these outbreaks, another (a bacteriological) conception was gradually being evolved, the two hypotheses developing concurrently and being to some extent complementary to one another.

Bollinger, in 1876, in an important paper read at Dusseldorf, drew attention to the great importance of meat poisoning and to the fact that many outbreaks were associated with pyaemic and septicaemic conditions of the animals from which the food was obtained. He pointed out that the toxins of these diseases were not destroyed by cooking.

In a later paper, in 1880, Bollinger collected the literature of the subject and was able to emphasise further the relationship between human food poisoning outbreaks and septic, pyaemic and gastro-intestinal conditions in the animals whose flesh was consumed. The bacteriological proof of this relationship was not however forthcoming for a number of years.

Amongst the first bacteriological investigations on the subject were those of Klein, in 1880 for the Local Government Board, into the outbreak of food poisoning at Welbeck (Notts), due to eating infected ham. No definite proof was however adduced that the bacteria isolated had caused the disease.

The first important landmark in the bacteriological investigation of food poisoning outbreaks was the isolation by Gaertner in 1888 of *Bacillus enteritidis* from a meat poisoning outbreak at Frankenhausen. The bacillus was isolated both from the fatal case and from the organs of the cow, killed on account of enteritis, the consumption of whose meat caused the outbreak.

Since that date this bacillus, or closely allied forms, have

been isolated from a very large number of outbreaks both in this country and abroad, and the etiological relationship has been firmly established. Indeed it is hardly too definite a statement to make that food poisoning of bacterial origin is very largely Gaertner group food poisoning and infection, and only in comparatively few cases are other bacilli associated etiologically.

The bacteriology of food poisoning also owes much to Van Ermengem. He investigated a number of outbreaks due to *B. enteritidis* and allied bacilli, while in particular, in 1896, he isolated and studied *B. botulinus*, the cause of an important group of food poisoning outbreaks (botulismus or sausage-poisoning), which were at one time especially numerous in Wurtemburg and other parts of South Germany. This form of food poisoning is unknown, or at least unrecognized, in this country. Although cases were reported in 1918 there was no real evidence that they were cases of botulism.

We owe an important further advance in the bacteriological study of food infections to Durham who demonstrated in 1898 that by the use of agglutination tests the bacilli isolated from food poisoning outbreaks, hitherto all indistinguishable, could be separated into at least two distinct groups. He also drew attention to the diagnostic value of the examination of the sera of patients suffering from food poisoning.

Independently, and nearly at the same time, De Nobele in Belgium came to similar conclusions.

On the epidemiological side this subject has received much attention from the Local Government Board. A very important summary of the then known etiological facts in relation to food poisoning was written in 1890 by Ballard (*Report of Medical Officer, Local Government Board*, 1890, p. 189), while an extended report on this subject, written by the writer, was issued in 1913 by the Local Government Board.

During the last twelve years or so a fresh impetus has been given to the subject and much additional light has been thrown upon it by the careful investigations which have been made as to the distribution of *B. enteritidis* and other bacilli

of the Gaertner group in nature and their relationship to different diseases in man and animals.

Owing to the greater attention which the subject has received, especially during recent years, the number of recorded outbreaks of food poisoning is now considerable. Ostertag, in 1902, was able to collect records of eighty-five epidemics in the period 1880–1900, mostly from German sources, while the writer in the above-mentioned report was able to give an account of seventy-nine outbreaks in Great Britain and Ireland alone.

CHAPTER II

FOOD AS A VEHICLE FOR TRANSMITTING BACTERIAL DISEASES

THE subject of parasitic disease, apart from bacteria, is outside the scope of this volume and the present chapter is restricted to bacterial diseases. It deals on the one hand with the diseases of the domestic animals which are also harmful to man through their flesh or milk, and on the other with the general question of food acting as a vehicle for the transmission of infectious disease. Food poisoning outbreaks from specific bacteria or from putrefactive changes generally are dealt with in separate chapters.

Bacterial diseases of animals which may be transmitted to man by their flesh or milk.

The domestic animals, like man, suffer from many bacterial diseases. Some of these are peculiar to the lower animals and are not shared with man while others are common to both. As regards these diseases it does not follow that they are conveyed through food to man because they are common to both man and animals. Theoretically they may be, but probably few are so transmitted, owing to considerations which are dealt with later on.

Edelmann's *Meat Hygiene Textbook* (Mohler and Eichhorn's translation, 1916) gives the following list of infectious diseases of animals used for food transmissible to man: tuberculosis, para-tuberculosis (Johne's disease), pseudo-tuberculosis, actinomycosis, botryomycosis, anthrax, rabies, glanders, foot and mouth disease, variola, tetanus, malignant oedema, septicaemia, pyaemia and putrid intoxication. To this series must be added a few diseases such as Malta fever and some varieties of mastitis (garget) conveyed by milk.