3 GEOGRAPHICAL MEDICINE

The great advances in medical science came with the use of the microscope and the discovery of bacteria and other organisms of disease by pioneers such as Pasteur and Koch. In earlier ages disease was associated with 'Airs, Waters and Places'. Even so, a simple exercise in medical geography had enabled Dr John Snow in 1849 to attribute an outbreak of cholera in London to infection of the water of the communal pump in Broad Street. Jenner, too, evidently recognised the infectious nature of smallpox when he immunised his patients with cowpox vaccine. However, both Snow and Jenner earned the ridicule of their colleagues of the medical profession. Snow overcame the ridicule and proved his point by removing the pump handle. Jenner was eventually justified by success.

However, if you believe that diseases are a function of Airs, Waters and Places, the obvious approach is to study them geographically, an approach which in this sense is as old as Hippocrates. This approach is entirely justified, since diseases undoubtedly are associated with places, and both air and water are common agents for their transmission. With the development of microbiology, knowledge of the actual agents of disease came rapidly and the science of immunology followed. However, the application of pharmacology to diseases of temperate climates lagged behind its application to tropical diseases in the refinement of such drugs as quinine for use against malaria, the arsenicals for sleeping sickness, and antimonials against leishmania and bilharzia. Sulphonamides, antibiotics and other anti-bacterial drugs were only developed more than fifty years later. Furthermore, the natural history of disease advanced more rapidly in tropical countries with the discovery by Ross of the transmission of malaria by mosquitoes and by the work of British and German scientists on the transmission of sleeping sickness by tsetse flies.

This situation highlights the fundamental difference between disease patterns in tropical and temperate climates. In hot countries many diseases are transmitted by insects and other intermediate vectors, which do not thrive so well in colder countries where they must pass the winter in hibernation or in the egg stage while still retaining infection. In the tropics, not only protozoa and helminth parasites are transmitted by vectors, but also a large and important group of viruses, the arboviruses

R. N. T-W-Fiennes, *The Environment of Man*

of which yellow fever is an important example. Insect-borne and similar diseases have a debilitating effect on the population, and account for the deaths of up to 20 per cent of children before puberty. The effect is more serious in settled populations in proportion to the numbers, because in such conditions the population of both parasites and vectors becomes larger and more concentrated. The effects on small groups of people who keep moving will be correspondingly less. It may well be supposed that these factors of disease were to a large extent responsible for preventing peoples in tropical areas from settling in large groups or—where they did—in undermining their stamina to such an extent as to frustrate the full development of their faculties. The local inhabitants developed some resistance, not shared by immigrants from temperate regions, who died like flies in the 'white man's graves':

> Beware, my son, the Bight of Benin,
> whence few come out, though many go in.

This is seen not only in the human populations, since domestic stock are equally at risk, and their loss from disease, famine or other causes contributes to shortages of food, especially protein, and thus to diseases, such as kwashiorkor, which increase the loss of stamina and performance of the people.

Much as the colonial era was disliked in tropical countries, this phase was undoubtedly indispensable to the people. For how else could these disease problems be studied and mastered and the people brought to a state of health and vigour in which they could order their own development?

The earliest advances in civilised living occurred in the Mediterranean basin, and it is tempting to suppose that this occurred because the Mediterranean climate is that most suited to man's performance. This theme has been developed by Gordon Manley in his book, *Climate and the British Scene* (1952, 1962 and 1970). Manley, a lawyer and at one time secretary to the British Prime Minister, Ramsay Macdonald, pointed out that the earliest centres of civilisation occurred along the 70° F isotherm, and that this happened not only in Europe, but also in the Americas, where civilised states were developed by the Aztecs and Incas, but nowhere else. He reckoned that civilisation only effectively moved northward when advanced heating methods were developed. Thus, as with the African situation, there were limitations to advance also in Europe and Asia, but the solution was more easily found.

It could be argued also that the 70° F mean isotherm line represented

the area where grains suitable for domestication existed, wheat, barley, rice and maize, and that Manley's correlation was not with climatic suitability for man, but with the grains. Nevertheless, the Mediterranean basin and comparable areas in South America and the Middle and Far East do represent the warmest parts of the earth, where a temperate rather than a tropical disease pattern prevails. Thus closer settlement was possible without the dangers of universally acquiring chronic debilitating diseases. However, the correlation is likely to be as much with seasonal variations of temperature as with the mean. There are many areas in tropical Africa with comparable *mean* temperatures, but owing to lack of variation throughout the year, parasitic vectors of disease do not have an interrupted growing season.

Problems posed by the river-based irrigational systems of agriculture were primarily due to the snail-transmitted diseases caused by trematode worms. Those prevalent in Africa are bilharzia (*Schistosoma haematobium* and *S. mansoni*; in the Far East *Clonorchis sinensis*). The eggs of these worms are passed in the urine in the case of *S. haematobium*, and in the faeces in the case of *S. mansoni. Clonorchis* infects cats as well as man, and the snails acquire larval infection from cats' faeces; however, a second larval form passes from the snail into a fish and man acquires infection by eating the fish. To eliminate bilharzia, therefore, is simple; you do not urinate or defaecate in water. In Egypt, the form of bilharzial infection is *S. haematobium,* resulting from the urine, but it is virtually impossible to prevent all the *fellahin* working in irrigation areas from contaminating the water. In any case, the dangers arising from urination into water have only recently become known.

Whereas, therefore, the development of city-dwelling in sub-Saharan Africa may well have been physically prevented by disease hazards arising from close settlement, in the river-based settlements close settlement was initially possible but debility and a decline of vigour in the people followed secondarily from their agricultural practices.

Civilisation in temperate areas got off to a reasonably good start, hazards of warfare apart. As early as Minoan times, there were forms of water-based sanitation. The Sumerians had deep pit latrines lined with earthenware pipes. The Romans built their Cloaca Maxima and flushed latrines with buckets of water. Furthermore, the cities were small, perched on tops of hills, and the peasant population lived on farms surrounding them; only when the invader came did they take refuge within the city walls. Mycenean settlements were of this type and so were Iron Age Celtic, such as Maiden Castle. Throughout Greek and Roman times the system seems to have worked reasonably well, though, as we have seen,

the Romans undermined their civilisation by a social system which could not endure. It was after the collapse of Rome that the world was swamped by Germanic and Nordic peoples who, unused to city life, turned cities into dunghills, rivers into sewers, and lived in a stench which must have been unbearable. Such conditions became steadily worse until the middle of the eighteenth century, when belated steps were taken to manage sewage and water supplies.

As can be supposed, medical conditions were deplorable. Rats abounded and spread plague, notably in the great epidemics of history; the Black Death in the fourteenth century killed half the population of Europe, and a heavy toll was taken by the Great Plague of 1665. The Enclosure Acts in Britain led to the peasantry being driven off the land and into the cities, and the Industrial Revolution led to the development of slums and appalling living and working conditions in the enlarged cities. Cholera, enteric, dysentery and other intestinal infections were rife. Tuberculosis was almost the rule rather than the exception. The death rate was phenomenal in rich and poor alike, though the poor suffered worse.

Rural areas were affected by the decline of the Roman roads system. Villages were cut off from each other to such an extent that a local food shortage might lead to famine and death, although a village twenty miles away had a food surplus. Furthermore, marriage between close relatives became so common that genetical defects and idiocy were widespread.

Improvement came slowly and conditions only changed radically with the invention of the anti-bacterial drugs and antibiotics during the Second World War. By their use, deaths from pneumonia and tuberculosis were to a large extent eliminated and the mortality statistics became radically changed, deaths from infectious causes giving pride of place to the so-called senescent diseases and the expectation of life becoming markedly extended. The situation had, of course, improved greatly and progressively from the mid-nineteenth century onwards, due to improved sanitation and communications. However, it was not until antibacterial agents were freely available that every child born had a reasonable chance of living in good health to the natural age of death.

In one way or another, whether in tropical or temperate areas, environmental factors associated with an unnatural way of life have impeded human progress in ways that are only now coming to be understood.

Hand in hand with industrialisation, there has appeared a new group of diseases, those known as 'occupational'. Today, these are the concern of industrial medicine, and factory laws continually take account

of new processes used and of a greater range of chemicals used in industry. The effects of some may be immediately apparent; with others, the effects are delayed, perhaps cancer in middle or later life. With others, as with lead and mercury, cause and effect may not be readily apparent. The traditional 'mad hatter' suffered from neurological changes resulting from the chemicals used to smooth the hats. Perfume workers at Grasse in France suffer liver damage from the essences of perfume distillation. Silicosis has long been associated with mine-workers; and today the even more dangerous asbestosis is all too common in persons working with asbestos used in the brake linings of cars. The general public, too, is at risk from agricultural, aerial and water-borne pollution in ways that are only now coming to be studied and controlled.

During man's history, the geography of medicine has not only been apparent in the distribution and incidence of infectious diseases. Nutritional problems have been at least as important if not more so. Whereas a great deal is now known about the control of infectious diseases, it can be argued that real understanding of nutrition is less far advanced. Some observers believe that the diet of agricultural and urban communities lacks the variety of that consumed by man's Stone Age ancestors. Agriculture is largely a method of making starch, so that with a monotonous diet large quantities of starch must be consumed to provide a sufficiency of nutriments required in small quantity but too highly diluted in agricultural products. This situation leads to diseases of civilisation, such as obesity and hardened arteries. In some parts of the world, where the diet is reasonably good, as in Ethiopia, people keep fit and perform their daily tasks adequately on a calorie intake which would be regarded as grossly inadequate in Western countries.

Primitive man found in wheat a grain of high value with a protein content of some 15 per cent and a satisfactory content of the essential amino acids. He quickly learned to supplement this with beans and other legumes, of which the protein content is even higher. As a dietary staple, therefore, wheat is satisfactory, but the same cannot be said of staple goods developed, particularly in tropical countries, where wheat will not grow. Such staples are the millets, sorghum, cassava, sago and bananas. Even maize and rice are less satisfactory than wheat. The disease of kwashiorkor, mentioned above, is rife throughout tropical countries, particularly in children. This disease is due to a deficiency of protein in the diet, and is associated with swollen belly, progressive wasting, and disease of the liver. Mental faculties are retarded and death eventually occurs. The symptoms are reversed when adequate protein is added to the diet. Where the people supplement the basic starchy diet

with fish or meat, or even beans, the disease does not occur. However, where such luxuries are scarce or reserved, as in times of famine, for the adult members of the household responsible for the heavy work of agriculture, the children are deprived.

It was not only in tropical countries that dietary problems arose. The existence of famine in English villages cut off from their neighbours has already been noted. At the beginning of winter in more northerly areas, as in Scotland, many of the cattle were slaughtered and the meat salted because of lack of winter feed. The people too had little to eat as winter progressed and vitamin deficiency diseases, especially rickets and scurvy, began to appear, though their association with deficiencies of diet was not known. There was little milk, few eggs, and no green vegetables until the spring. Vegetables were, indeed, scarce in winter even in prosperous households right up to the First World War. The rapid appearance of scurvy in ships' crews was an indication of how short the winter diet was in vitamin C. This shortage was partially alleviated when potatoes were introduced. Not only are potatoes a valuable food, rich in protein, but even today they are the major source of vitamin C for the majority of the population. Even so, the older potatoes eaten in winter contain less vitamin C than do younger ones of the early crop. Nutritional diseases, then, were a debilitating factor even in temperate climates, and the short stature of the poorer people was probably associated in no small degree with a periodical absolute shortage of food. Such shortages would, of course, render the people even more susceptible to infectious diseases. Shortage of vitamin D, present in milk, butter, eggs, fish and liver, led to the development of rickets in a proportion of persons to whom these foods were not available. In the summer, the shortage would be less marked because of the effect of sunlight in synthesising it in the skin. However, such an effect was diminished in the big smoky cities, through the atmosphere of which the ultra-violet rays were less able to penetrate. Just how marginal the intake still is of vitamin D is shown by a renewed incidence of rickets in dark-skinned immigrant children in Britain at the present time.

The geographical incidence of disease distribution is used today for the study of the causes of disease. Where there is a high incidence of a particular disease in a certain area, then special factors may be looked for in those areas to account for it. In Derbyshire—and many other areas in the world—there is a high incidence of goitre, due to enlargement of the thyroid gland, known as 'Derbyshire Neck'; this condition is due to a deficiency of iodine. Iron deficiencies lead to iron-deficiency anaemia. Shortage of fluoride in the water leads to caries and tooth decay. There

may be a number of other deficiencies of minerals required in trace amounts, the effects of which are not yet known but require study.

One of the more interesting associations, not yet understood, is the relationship of cardio-vascular disease with soft water. In hard-water areas, deaths from diseases of the cardio-vascular system. such as coronary heart disease and stroke, are statistically lower than in soft-water areas. Experiments have failed to reproduce this effect in experimental animals, such as pigs and rats, so what property of the hard water contributes to the lowering of this incidence is not known. It is generally supposed that this might be one of the elements present in hard water, rather than the hardness of the water itself. Such might be zinc, vanadium, magnesium, molybdenum, or some other element.

Cardio-vascular disease, at present classed as a disease of senescence, today precedes cancer as the major cause of death. Changes in the arteries are found in young men in their twenties and thirties. Yet in more primitive peoples it either does not occur or is very rare. Is this a racial characteristic or is it related to dietary habits? Evidence suggests that it is related to diet. There is a Western-type incidence amongst Arabs in Israel, whereas outside Israel the incidence is low; the Israel Arabs consume a Western-type diet, the others their traditional diet. The high incidence amongst Western peoples has been variously attributed to their high intake of cane sugar, to their consumption of solid fats instead of oils, sedentary habits, and so on. Disease of the cardio-vascular system may well prove to be preventible; if so, much misery and distress could be avoided and the life tables would look much better.

The second-highest cause of death in Western societies is cancer. There are many different types of cancer, some of which may be analysed by geographical medicine. Cancer of the cervix in women has a lower incidence in races which practise male circumcision. From this, it is argued that the cause is infection, probably a virus, and that the virus is present in the male smegma which accumulates below the prepuce (the foreskin). Other cancers have a high incidence in certain areas, and causal factors are sought for them peculiar to those areas. A typical example of successful geographical sleuthing was that of the Burkitt Lymphoma.

The Burkitt Lymphoma is an eroding tumour of the jaw bones which occurs in tropical areas, particularly in Uganda, where it was investigated by a British doctor, Dr Denis Burkitt, after whom it is named. It affects young children of ages 8 to 12, and rapidly results in death. Attempts at surgery were unsuccessful, though it can now be cured in some cases by suitable drugs. Dr Burkitt noticed that these tumours only

occurred in those areas of Uganda where malaria was endemic. He therefore supposed that the tumour was caused by some infectious agent, probably a virus, whose effect was enhanced by malarial infection. A virus has since been isolated from these tumours by two British scientists, Drs Epstein and Barr, which belongs to the herpes group of viruses and which in other areas causes glandular fever.

To complete this short review of geographical medicine, it is necessary to study the subject of man/animal relationships—the diseases of man that can be transmitted to animals (anthroponoses) and those of animals that can be transmitted to man (zoonoses). These are of two types, those arising from contact with wild animals, and those arising from contact with domestic animals.

All wild animals carry some burden of parasites and potential pathogens, which may take their toll between weaning and puberty or in old age. The general adult population comes into balance with them, so that they are not harmful, unless stressing factors such as food shortage or over-population become established. These remarks apply as equally to primitive human communities as to other animals. Many pathogens and parasites are spread directly from one animal to another by direct or indirect contact, indirect contact being by way of contaminated soil, vegetation or tree bark and so on. In such an event, usually only one species is host to the parasite. However, there is a form of relationship between prey and predator species, which is important to parasite transmission. In its simplest form, this is seen in the transmission of the common tapeworm of Canidae, including domestic dogs. The adult tapeworm lives in the gut of the canid; eggs are passed in the faeces and contaminate pastures; the larvae are consumed by grazing animals, deer or sheep; the larvae form cysts in the abdominal cavity of the grazer. If the herbivore host is killed by a dog or a wolf, the tapeworm cyst is eaten and the predator acquires infection.

A particularly nasty tapeworm is a minute parasite of dogs, known as *chinococcus granulosus.* Although the adult tapeworm is minute, the larval cyst—known as 'hydatid'—grows continuously and becomes enormous; it becomes attached to the secondary host's liver or other organs, which may be largely destroyed. The secondary host may be a sheep or a horse or a donkey—or man. This worm has become a major danger at sheep-shearing stations as far removed geographically as Wales and Australia. When the sheep are brought in for shearing, those that are infected with hydatid may die or be killed because they are in poor condition. The carcasses are then given to the sheepdogs, which become heavily infected with the adult worm. It is very easy for the sheep shearers

to get their hands contaminated with the dog's excreta in such situations, and in this way they can acquire hydatid, unless they are careful about washing before they take a snack.

Man's own natural predator/prey relationships are with cattle and pigs, which harbour the cysts of human tapeworm in their muscles—known as 'measles'. Infection can only reach these animals if infected persons defaecate in the pastures where they graze. Man is infected by eating the meat, which is not rendered safe by normal cooking procedures. In Western countries, tapeworm infection is rare because standards of personal hygiene are high and beef and pork are inspected at abattoirs. In less advanced countries, the infection rate may be high, though the worms do little harm. However, pigs in some areas also have a high infection rate with a roundworm, called *Trichinella spiralis.* This worm encysts in the muscles, and if the flesh is eaten infects the muscles of the person eating it. This parasite can cause severe muscular pains and distress in breathing because it gets lodged in the respiratory muscles, and people sometimes die as a result. It is sometimes said that taboos against eating pork originally arose because the dangers of this parasite were recognised.

The conditions so far mentioned are those associated with normal predator/prey relationships. They do not normally become widely distributed or necessarily dangerous except in special circumstances, as with the sheep-shearing situation, or where intensive agriculture leads to an unnaturally high degree of stocking. In two other types of situation, zoonoses can be much more dangerous: first, in population explosions of wild animals, where they tend to migrate and their natural bacteria and viruses cause active disease under the stress; second, when there are unnatural contacts between species that normally live apart.

The well-known lemming migrations are a typical instance of the first type of hazard. Lemmings normally carry, as a normal commensal, the bacterial agent of a serious disease of man known as tularaemia, caused by *Pasteurella tularensis.* When the migrations occur, the lemmings in great columns migrate over fields and through villages; some die and some are eaten by dogs and birds and invariably there are outbreaks of 'lemming fever' amongst the human populations. The great outbreaks of plague, which occurred periodically from Roman times throughout the Middle Ages, were associated with massive migrations of the black rat from the Far East; they not only swarmed over the land surfaces, but got into ships and so were distributed all over the old world. The causal agent, *Pasteurella pestis*, is a normal commensal

of voles and other rodents; infection was passed to the black rats, which began to die and migrated. Rabies is another instance of this type of situation. In some areas it is endemic in wild carnivores, such as foxes and skunks or in bats. Domestic dogs become infected from the wild carnivores, and man is at risk from the dogs.

Unnatural contacts between man and dangerous animals have become more frequent because of the importation of exotic species as pets, or for research. Many deaths have occurred from psittacosis acquired from parrots. Deaths of children have occurred from salmonella infections acquired from imported tortoises. Skunks can be unaffected carriers of rabies. However, the most dangerous animals to man are those most closely related to him, his fellow primates. From them can be acquired such diseases as bacillary and amoebic dysentery, B. virus infection, Marburg Disease, infectious hepatitis, tuberculosis and rabies. Many people have died as a result of contact with these animals. Under jungle conditions too, unnatural conditions can fortuitously occur. Yellow fever is transmitted in the jungle from monkey to monkey by mosquitoes, which normally live high up in the trees. The monkeys in most areas are unharmed by it. However, if woodcutters fell a tree in the forest, they may be bitten by infected mosquitoes which come down with the tree. The virus can then pass from the infected person into certain domestic mosquitoes and an epidemic with numerous fatalities may be started. Many more examples could be cited.

The geography of medicine, therefore, has many facets. Man has created many unnatural situations with the result that unusual problems have continued to arise, by which the health and performance of his peoples have been threatened and impaired. It has been possible in this brief survey to give only the barest outlines of the subject, though certain aspects will be elaborated in succeeding chapters. In the next chapter, we shall look in greater detail at the nutritional problems of civilisation, which may be less well understood than those of infectious disease.