Zoonoses and the Origins and Ecology of Human Disease

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Preface

The purpose of this book is not to give a catalogue of animal diseases, from which man can suffer; rather, the human disease pattern is reviewed in relation to ecology—the relationships of man with his environment and with the animals with which he associates. In the penultimate chapter, the part played in human disease by marine biology is briefly discussed, since it is likely to become increasingly important and has not hitherto been evaluated.

It is evident that the human disease pattern has changed fundamentally since populations became increasingly concentrated in towns and cities. A number of entirely new diseases have appeared, not shared with any kind of animal, which require minimal population densities for survival. Many such diseases must have arisen from pathogens of animal origins, which have become adapted to man as the sole host. In this sense, they are "remote zoonoses". There is also evidence that this trend in disease evolution is by no means past, and that "new" or new sub-types of existing diseases are still becoming adapted to the human host.

The emergence of new diseases could well result in pandemic episodes which could kill a great many people in many parts of the world before control could be effected. World conditions today resemble those which in the past have preceded the appearance of global pandemics and the dangers should be realised.

This book, then, does not supersede existing works on zoonoses, which are of high merit and cover the field comprehensively. It does seek to expand the areas of thought on the subject, in ways which appear, to the author, to be of fundamental importance. This importance is emphasised by study of the part played by suddenly-appearing new diseases on human history, the course of which has been changed as a result at various times for better or for worse.

References have, in so far as possible, been limited to general articles and books on the subject in question. Current thought on the influenza problem has been so recently developed, that I have needed personal guidance and assistance. This has been readily accorded, and I wish to acknowledge my debt to Dr. G. C. Schild of the Medical

Research Council Influenza Unit, and to Professor W. I. B. Beveridge and Dr. Abdusalam of the World Health Organization.

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Introduction

Introduction

On May 14th 1796, Edward Jenner inoculated a boy named James Phipps with fluid from a vesicle on the finger of a dairy maid, Sarah Nelmes. Sarah had contracted cowpox from the udder of a cow that she had been milking. Neither Sarah nor the cow were at all sick, except for the inconvenience of local lesions on the skin of finger and udder. Jenner was testing the age-old belief in the West Country that persons, who had suffered from cowpox, did not contract smallpox. On July 1st of the same year, he administered to James vesicle material from a smallpox case. James did not contract smallpox, nor did 22 other persons on whom Jenner subsequently tried his technique.

Today, there would no doubt be an outcry from humanitarian societies, broadcast through the mass media, at Jenner's inhumanity in exposing the boy to the danger of contracting a deforming and often fatal disease. There was no such outcry, but members of the medical profession were frankly disbelieving and obstructed the introduction of vaccination. It was, at the time, common practice to infect exposed persons deliberately with small inoculations of smallpox material in the hope that the resulting disease would be milder than if naturally acquired; it did not, therefore, seem so outrageous for Jenner to infect the boy as might appear today.

These events occurred fifty years before Koch and Pasteur, and before the infectious nature of disease had been demonstrated. The Great Plague of 1665 had occurred only 131 years before and was believed to be wafted by the southern wind and due to poisonous vapours. It was fifty years later that Chadwick removed the handle from the Fleet pump, convinced that contamination of the water supply was the cause of cholera. Life expectation was short; early death and all manner of tragedy were accepted with resignation and ascribed to the will of God.

The well known story of Jenner and the cowpox is of interest for a number of reasons. Long before there was any understanding of the infectious causes of disease he did, on an empirical basis, find a means of protecting people from one of the most serious. It is interesting,

because he proceeded on the basis of an "old wives' tale", though why the old wives had not long since ensured that everybody suffered from cowpox is difficult to discern except by acceptance of the divine will.

It is also interesting in our context, because the disease from which Sarah Nelmes was suffering was a "zoonosis"; it was a disease of cattle, which could be transmitted to human beings, in this case in a very mild form as in the cattle. It appears to have been recognised that people did contract disease from animals, though this recognition was probably confined to obvious cases such as cowpox, in which the connection could not very well be overlooked. Disease cycles involving intermediate hosts were not only unrecognised but seemed so absurd as to be laughable. That acute observer, the explorer Richard Burton, mentioned in his "First Footsteps in East Africa" the belief amongst Somali tribesmen that malaria was somehow connected with mosquitos, a belief — so he thought — typical of primitive people whose society was riddled with superstition. Even so, the Philistines in the days of King Hezekiah of Judah seem to have recognised the connection of plague with rodents, since when pestilence fell on them they appeased the god of Israel by offerings of golden mice. Furthermore, the connection of dirt and lice with outbreaks of typhus was certainly understood in a vague sort of way.

Etymology

When preparing my book "Zoonoses of Primates", I was prompted to undertake some research into the origin of the word "zoonoses"; it seemed to me that the word was in frequent use, but nobody seemed to understand its precise meaning. In this, I was assisted by a German lady, the late Miss E. von Bernuth, and the results appear more fully in my book. The use of the term had appeared in German and French medical lexicons by the middle of the nineteenth century. For example, Probstmayer (1863) in his "Dictionary of Veterinary Medicine" defined zoonoses as: — "Zoonoses are firstly original animal diseases; secondarily, diseases of man which can be transmitted to him by means of a contagion from animals." Evidently, the term had been in use for some length of time before finding its way into the dictionaries. British scientists have attributed the word to the great German pathologist, Virchow (1821-1902), in the belief that he had coined it. This, however, is not the case; Miss Bernuth, in spite of a careful search of his writings, could discover no instance in which he used the term other than in a strictly orthodox way as defined above. In its strict sense the term means merely an animal disease in man, or indeed simply an animal disease.

The concept then was originally without subtlety and seems to have fallen into disuse until after the Second World War. During the past twenty years, it has come into its own again particularly in tropical medicine, because of the realisation that so many diseases are passed, in one way or another, between animal and man and because they are so important. Zoonoses have thus become a new and fascinating branch of medical science in their own right. They could hardly have become so, until a knowledge had been acquired of transmissible pathogens and of the intricacies of disease cycles. Inevitably, the term zoonosis has acquired a wider meaning and indeed has become a new science.

Like all new sciences, that of zoonoses has tended to acquire a terminology of its own, most of it unnecessary and some of it etymologically unsound. Thus, if a zoonosis is an animal disease transmissible to man, what is a human disease transmissible to an animal? This difficulty was solved by introducing the term "anthroponosis". If these two terms are accepted, another term is necessary for diseases from which both animals and man can suffer and which can be passed in either direction from one to the other. This problem gave rise to the term "amphixenosis", which is meaningless in terms of its Greek derivations. There are also terms such as "anthropozoonosis" and "zooanthroponosis". Even further into the realms of fantasy are terms such as protozoonosis and helminthozoonosis, meant to mean protozoan and helminth diseases transmissible from animals to man, but which literally mean diseases of protozoa and helminths from which man can also suffer.

These terms are all best discarded with the possible exception of anthroponosis, though there is little necessity even for this. We are concerned with the dangers of animal disease to man; the dangers of human diseases for animals, with the possible exception of tuberculosis in monkey colonies, are secondary. In any case, man is a ZŌŎN (ζωον) as an animal, so that zoonoses can be used correctly for the two way passage of diseases.

Throughout this work, I use the terms pandemic, epidemic and endemic, whether referring to disease in man and animals. Substitution of the terms panzootic, epizootic and enzootic is both unnecessary and confusing. Reference to Liddell and Scott's Greek Lexicon will show that the greek word "démŏs" (δημοσ) can refer to a crowd of either human beings or of animals, although in its derived meaning it usually refers to the former. Primatologists using the English language have difficulty in the use of the word primate, which includes man. Whereas in German the word "affen" and in French "singe" mean both apes and monkeys, there is no word in English to cover both groups, and phrases such as "non-human primates" are commonly

used. The late Dr. Hamish Innes suggested that the difficulty could be overcome by using "simian primates" or "simians" for short to cover both apes and monkeys. Purists may object to using the adjective as a noun, but we do the same with "humans"; convenience of expression must prevail. I, therefore, accept Dr. Innes' proposed usage.

Scope and Argument

Since its inception, then, the term zoonosis has been greatly widened, especially by its application to vector-borne diseases. This again present problems as to what may justifiably be regarded as a zoonosis. For example is Yellow Fever a zoonosis? It is a disease which can affect man as well as monkeys, though endemic only in the latter; yet mosquitos are the reservoirs of the virus, and strictly speaking it is not a primate zoonosis but a mosquito zoonosis. Unless we allow some flexibility to the term zoonosis, we find ourselves in difficulty.

These difficulties become greater when, as in this book, one attempts to place zoonoses against a background of disease ecology; in this context, the term zoonosis must be stretched beyond limits which some readers may regard as permissible. There are three main aspects of the subject to be tackled. The first is to study those diseases which are group specific to man, but must have had their origins as zoonoses in the remote past; they are "remote zoonoses", though they are not zoonoses today. Secondly, we study new diseases which may be establishing themselves in man today as a result of his changed ecological circumstances. Thirdly, an account will be given of those diseases derived from animal sources, which create special problems in the modern world. To cover this brief, as I feel it should be covered, I find myself examining the problem of diseases caused by or derived from marine creatures, which do not normally feature in works on zoonoses. If an oyster concentrates the pathogens of typhoid or infectious hepatitis and transmits the disease to a human patient, is this a zoonosis? The dividing line is blurred. When fish are dying as a result of a "red tide" and persons who eat them become sick, they have acquired a disease of fish, a fish zoonosis. If they become sick from eating fish, which have concentrated a heavy metal such as mercury, is this a zoonosis? The Greek word "nŏsŏs" means merely illness or pathology; it does not stipulate that the cause must be a living organism.

I am then using the word zoonosis to cover those aspects of human medical ecology, which depend on man-animal relationships. These relationships are very variable and they have varied greatly throughout history. They differ between Stone Age hunting communities and

settled rural and urban communities. They also differ with trades and professions; people who handle animals or animal products are at greater risk than those who do not. The life cycles of parasites are an equally important factor; the connection between a disease of monkeys in the forest and one of human village dwellers, Kyasanur Forest Disease, was not readily apparent until the role of a three host tick was understood; the larvae live on the monkeys in the trees and the nymphs carry infection to cattle and so to the village dwellers. The connection was even more difficult to discover with Yellow Fever in Africa, since the monkeys there show no symptoms when infected. The life cycles of animals which form the disease reservoir must also be taken into account. Some animals migrate seasonally; some hibernate or aestivate; with others there are population explosions every few years when animals overflow their natural boundaries as with lemmings; their natural commensals in stressed conditions cause active symptoms of diseases, such as tularaemia, which prove serious when transmitted to man from his dogs which gorge on the lemmings. Rodents, such as field mice and voles, tend to leave the fields after the harvest and enter human settlements, often introducing infection or contaminating foodstuffs with their faeces.

References

I have then in this work tried to introduce a new angle to the study of zoonoses, which appears to me to be of importance and also of great interest; the material offered is accordingly selective. There are a number of excellent works on zoonoses, which I have used freely to ascertain my facts. Outstanding as a work of reference is van der Hoeden's (1964) "Zoonoses". Another valuable work is Bisseru's (1967) "Diseases of Man acquired from his Pets", which is much more comprehensive than the title might imply. Soulsby's "Parasitic Zoonoses" is invaluable in the field it covers. I have also made reference throughout to a number of works, which I have myself either written or edited, because the material is most readily available in them. The most important of these are:— "Zoonoses of Primates" (Fiennes, 1967) and "Pathology of Simian Primates" (Fiennes, ed. 1972).

The works quoted are fully referenced. I am, however, including a supplementary reference list covering the major publications on Influenza and Transmissible Cancer, although reference to them is not specifically made in the text. Newer concepts of the origins of influenza pandemics are so recent that the literature is unlikely to be widely known, and Beveridge (1977) has not included references in his

"Influenza—the Last Great Plague". The milestones and advances in transmissible cancer research seem to be so little known in Britain, that inclusion of a bibliography may be helpful. Furthermore, I have deliberately covered this subject in the most truncated way possible, because of expressed scepticism about the suggestion made that any form of cancer could prove to have its origins as a zoonosis.

Contents

PART I

The Evolution of Human Diseases from Animal Counterparts

CHAPTER 1

Man-Animal Relationships

The Human Environment

Man has existed as *Homo* for at least two million years, of which the past 700 000 have comprised the Pleistocene Epoch occupied by the great Ice Age. During the Ice Age, there were four periods of glaciation separated by three interglacial periods, during which the climate became much warmer in northern regions, even sub-tropical. The sequence of glacial and interglacial is shown by Fig. 1 and the extent of the polar ice cap by Fig. 2 (see also Table 1).

The ancestors of modern man were basically ill adapted to life in arctic tundra and could only survive because of their hunting skills, which provided them not only with food but with animal furs for warm clothing; the use of fire also was necessary both for warmth and for cooking foods unsuited to a light tooth apparatus. In the tundra, however, man found an unoccupied ecological niche with abundant resources and no other major predator except wolves, and with a challenge which his high intelligence enabled him to exploit. Most predators hunt by stealth and cannot exploit open habitats, such as the Ice Age offered. Conversely, the special hunting skills developed by both wolves and man were less suited to the forests, which became developed during the warm interglacials and when the Pleistocene Epoch ended some 12 000 years ago. Fossil evidence, as from the great boulder clays of Norfolk, England, show clearly that during the warm intervals of the Ice Age, numbers of both wolves and man decreased greatly and the wolves became much smaller, Fiennes (1976).

The ecological steps and the time sequence, by which forests again encroached on the tundra at the end of the Pleistocene, are described by Cornwall (1959), from whom Table 2 is taken. Man was again forced into retreat, but reacted in a fashion novel in ecological history by attempting to adapt a new and hostile environment to his needs. The consequences both to man and the environment have been

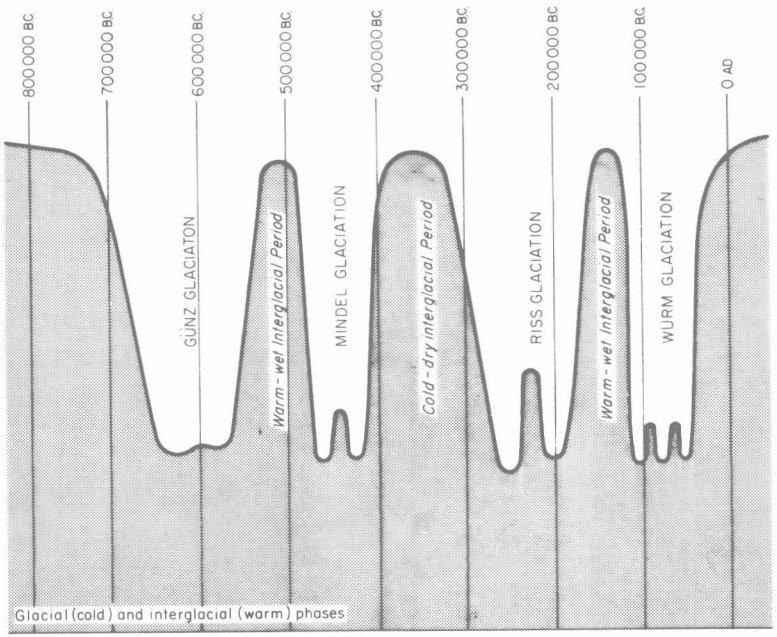


Fig. 1. Sequence of glacial and interglacial periods during the great Ice Age.

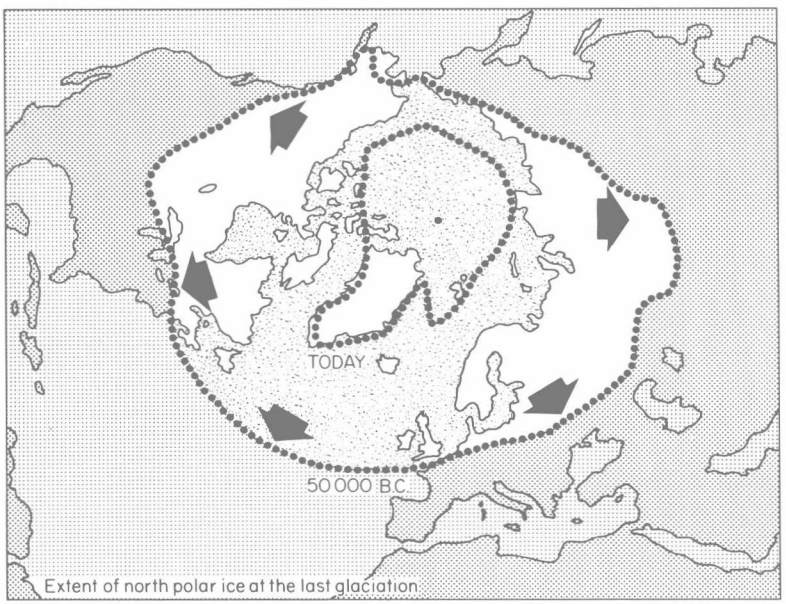
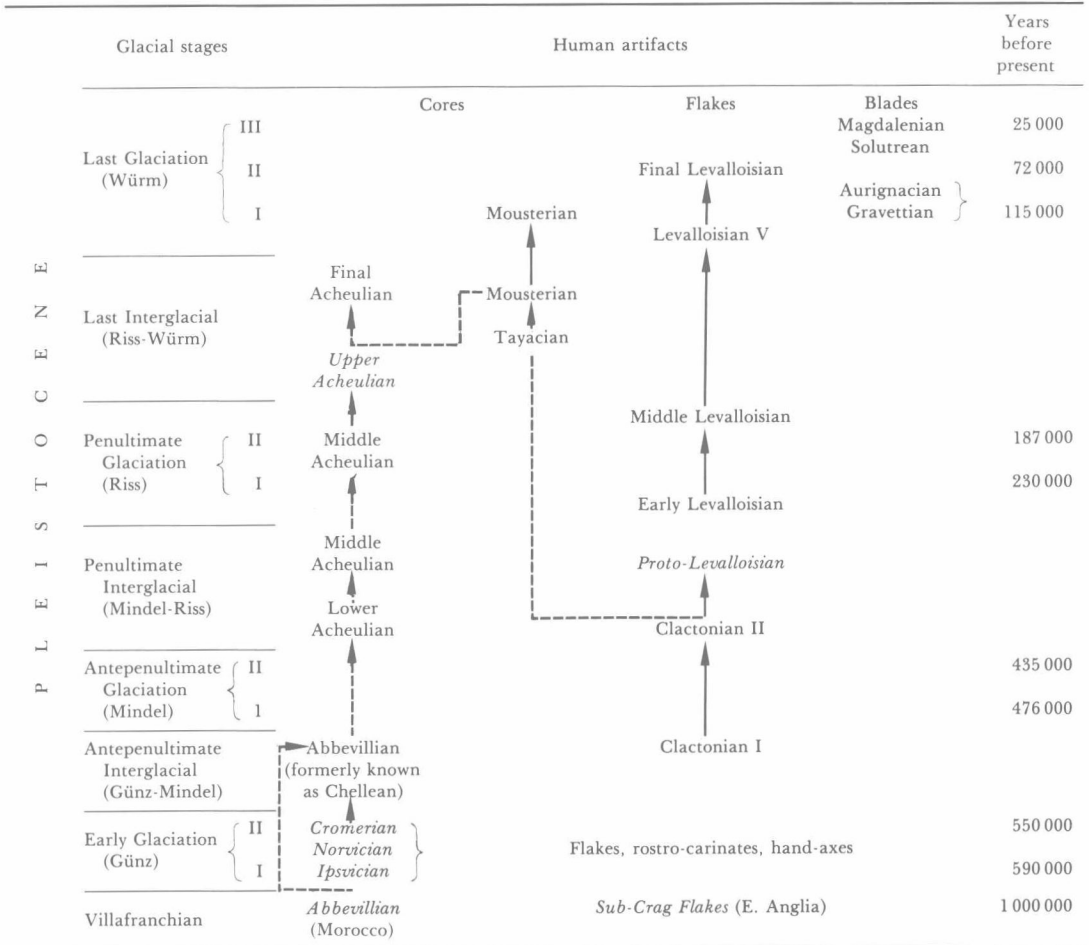


Fig. 2. Extent of the polar ice cap during the great Ice Age.

TABLE 1

Palaeolithic chronology in west and central Europe (After Cornwall, 1959)



(Uncertainties are printed in italics)