

MAMMALS - CARRIERS OF DISEASES DANGEROUS TO MAN*)

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Abstract. An analysis is given of the involvement of different mammals in the circulation of the pathogens of various natural focus diseases.

Diseases whose pathogens are naturally transmitted from vertebrate animals to man are called zoonoses (Joint FAO-WHO Expert Committee on Zoonoses, 3rd Report, 1969, p. 7). More than 250 such infections and invasions are known. The overwhelming majority belongs to a group of diseases which a distinguished Soviet scientist E. N. Pavlovsky (1947, 1948, 1964) suggested to call natural foci diseases. The causative agents of these diseases circulate regularly in populations of wild animals. Man is of no consequence for their existence. He is not involved in the circulation of the causative agent. Infection of man is accidental, and, as a rule, is a blind alley for the pathogen. In most cases this is due to the absence of a specific mechanism for the transmission of the causative agent of the given disease (Gromashevsky 1958). However, even when such mechanism does exist, in due course the human epidemics become attenuated, self-liquidated (plague, zoonotic cutaneous leishmaniasis) or may be eradicated rather easily (urban yellow fever). The parasitization of pathogens of natural foci diseases in a human organism is accidental and inconsequential. To the contrary, the danger of infection for a person arriving in a natural focus (a territory with a continuous circulation of the pathogen) is quite great and at times practically unavoidable. In natural foci diseases the epidemic process in its classical interpretation is absent. There is no continuous chain of cases of the disease in people. Infection can occur either instantaneously from a single source after the pattern of group toxicoinfections, or each person is infected separately without any connection with other patients. Thus, an epidemic of natural foci diseases is a sum total of separate cases which occur in different places, often quite distant from one another.

There are two main routes by which man get infected with diseases of wild mammals. The first is when people visit a natural focus. When the visits are numerous and coincide with mass epizootics, there may be regular human cases of infection. The necessary condition is either the presence of highly man-aggressive vectors or heavy contamination of untreated agricultural products, water, etc. by the pathogen eliminated along with the excreta. The combination of the mentioned conditions might give rise to epidemics with dozens, hundreds and at times thousands of human cases.

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The second route is the importation of the disease to human dwellings. It may be realized by mammals migrating to dwellings, by blood-sucking Diptera which fly to the communities and by delivering fuel, forage and farm produce contaminated with the pathogen. In this case group infections whose number is determined both by the spread and intensity of epizootics in nature and by the intensity of the importation of the disease to communities are unavoidable. In some cases this importation causes an additional cycle of the pathogen's circulation among synanthropic mammals.

The diseases of mammals, which are transmitted to man are still of a great social and economic importance. According to WHO materials, at least 7 million people in South and Central America and in the southern regions of the United States are infected with *Trypanosoma cruzi*—the causative agent of the Chagas' disease and about 35 million people are exposed to the risk of this infection. Prior to mass vaccination against tularemia, there were years in the USSR when as many as 150,000 tularemia cases were registered. At present some 60 million people have been vaccinated in the USSR against tularemia (Baroyan 1958, Olsufyev and Dunaeva 1970). The brucellosis control programme in the United States has cost 850 million dollars from 1934 to date; in 1972 alone the relevant control measures cost 30 million dollars (Wisent 1973, De Young 1973). The diseases of wild mammals which are dangerous to man, regularly evade control even in densely populated and well-developed European countries. An instance of this is the wave of epizootics of fox rabies, which swept in the recent decades the majority of West European countries: Austria, Belgium, the German Democratic Republic, Denmark, France, the Federal Republic of Germany, Switzerland and other countries (Ganslmayer 1968, Goert and Toma 1968, Kaplan 1969, WHO Chronicle 1970). Mass epizootics of tularemia with a considerable number of human cases in the sixties took place in Central European countries (Puntigam 1960). In Sweden, with a population of about 8 million people an outbreak of tularemia with approximately 3,000 cases was registered in the winter of 1966—1967. In some communities up to 20 per cent of the residents were afflicted with this disease (Dahlstrand et al. 1971).

We shall consider in greater detail the mammal diseases of viral, bacterial and protozoan ethiology. The diseases caused by multicellular parasites will not be dealt with.

At present we can give a sufficiently detailed description of 30 diseases of mammals which are of considerable importance in human infectious pathology. They include ten diseases of viral ethiology (rabies, lymphocytic choriomeningitis, yellow fever, tick-borne encephalitis, different haemorrhagic fevers). Six diseases are associated with rickettsiae — Q-fever, tsutsugamushi, vesicular rickettsiosis, murine and tick-borne typhus fevers. Nine diseases are caused by bacteria (plague, pseudotuberculosis, tularemia, brucellosis, listeriosis, erysipeloid, anthrax, leptospirosis, tick-borne spirochetosis). Finally, five infections are of protozoal ethiology—African trypanosomosis, Chagas' disease, cutaneous and visceral leishmaniases (Table 1).

An estimate has been made of the number of species of mammals belonging to different orders that are infected with these diseases under natural conditions. It has been found that in most diseases dangerous to man, the range of species involved in epizootics is extremely wide. For instance, more than 100 mammals species belonging to 10 orders are known to be naturally infected with leptospirosis (Karaseva and Sveshnikova 1971, Soloshenko 1971), 220 species of 7 orders with plague (Expert Committee on Plague, Third Report, 1959, Rall 1960), 120 species of 7 orders with tularemia (Olsufyev and Dunaeva 1970, Reilly 1970), more than 100 species of 8 orders with Q-fever (Fyodorova 1968, Shekhanov 1970), more than 100 species of 8 orders with rabies (Ganslmayer 1968, Kantorovich 1968, Mc Lean 1970),

Table 1. Importance of representation of different mammal orders as carriers of diseases dangerous to man

Mammal orders and number of species in them	Spontaneous infection (-) or presence of main hosts (++) of a disease* in individual species of order																			
	Monotremata	Marsupialia	Insectivora	Dermoptera	Chiroptera	Primates	Edentata	Pholidota	Lagomorpha	Rodentia	Mysticeti	Odontoceti	Carnivora	Pinnipedia	Tubulidentata	Proboscidea	Hyracoidea	Sirenia	Perissodactyla	Artiodactyla
6	242	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Marsupialia	406	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Insectivora	2																			
Dermoptera																				
Chiroptera	875																			
Primates	166																			
Edentata	31																			
Pholidota	8																			
Lagomorpha	63	++	+	+	++	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Rodentia	1687	++	+	+	++	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Mysticeti	10																			
Odontoceti	74																			
Carnivora	253	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Pinnipedia	31																			
Tubulidentata	1																			
Proboscidea	2																			
Hyracoidea	11	-																		
Sirenia	5																			
Perissodactyla	16	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Artiodactyla	131	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

approximately 100 species of 8 orders with the Chagas' disease (Hoare 1972), etc. At the same time the number of the main hosts, i.e. species of mammal which ensure the continuity of pathogen's circulation is relatively small in each disease. Quite frequently the main hosts belong to 1—2, more rarely to 3 or more than 3 orders. For instance, all the main hosts of anthrax and African trypanosomiasis belong to the order of Artiodactyla, the majority of endemic rickettsioses belong to Rodentia, those of brucellosis to Artiodactyla and Lagomorpha, those of listeriosis to Artiodactyla and Rodentia, those of plague and tularemia to Rodentia and Lagomorpha, rabies to Carnivora and Chiroptera. Only the Chagas' disease and leptospirosis*) are characterized by main hosts which belong to 4 and 5 orders.

Rodentia, as hosts of human diseases are of greatest importance among all orders of mammals. Natural infection of rodents is known for 28 out of 30 discussed diseases and in 25 of them the rodents represent the main hosts. This is explained by a number of reasons. This order achieved its peak of development in the present epoch. Rodentia account for 1,687 out of a total of 4,060 recent species of mammals (Anderson and Jones 1967). The representatives of this order inhabit all continents of the world. In most biocoenoses of land surface they belong to the dominating forms and comprise the bulk of the biomass of mammals. Rodents constitute a great number of biomorphs and make use of most differing habitats. They include semiaquacous inhabitants of the water reservoirs and marches. A considerable number of their species live in trees, some are flying or rather gliding forms. Rodents include specific inhabitants of rocks and stony debris. There are species which move by means of a ricochet run, and there are fossorial forms which spend practically all their lives under the ground.

Only the order Rodentia is characterized by various types of feeding. The bulk of rodents are phytophags including those specializing in the consumption of bark and branches, green grassy plants, roots and bulbs, different seeds, and fruit meat. Rodents include also primarily insectivorous, predatory or piscivorous species (Thenius 1972).

It is the rodents, in most landscapes, that are the main builders of specific shelters: diverse burrows and nests. These shelters, in their turn, are the main habitats of numerous arthropods, including blood-sucking parasites. The main stages of their life cycle take place in rodent nests and burrows. The mentioned properties predetermine the role of rodents as the most important hosts of the majority of blood-sucking ticks and mites (Ixodoidea, Gamasoidea, Trombiculidae), fleas, sandflies and some other arthropods. Only the rodents, among wild mammals, have become permanent co-habitants of man and can inhabit modern towns and structures. Some rodents yield good pelts and serve the purpose of fur trade. Some large species are widely used by local people for food (Kucheruk 1964).

The abundance of rodent species and life forms creates various routes of transmitting causative agents of those diseases where these animals are the main hosts. Seven diseases are passed by the non-transmissive way (alimentary, aerogenous, as a result of contact with contaminated water), in five others the main vectors are ixodid and argasid ticks, in four diseases the transmission is done by sandflies and one causative agent is transmitted by the triatomid bugs, three diseases are characterized by various mechanisms of transmission. As main vectors in diseases of rodents only Siphonaptera (plague, murine typhus fever), Gamasoidea (vesicular rickettsiosis) and Trombiculidae (tsutsugamushi) are recorded. Among wild mammals only synanthropic rodents ensure the specific cycle of the pathogen's circulation in human communities.

*) This circumstance confirms the view that leptospirosis is not a single nosological form but a group of infections caused by different species of pathogens.

and dwellings (vesicular rickettsiosis, murine typhus fever, lymphocytic choriomeningitis, plague, haemorrhagic fever with a renal syndrome).

The second in importance regarding the carriage of diseases dangerous to man is the order Artiodactyla. Natural infection of animals belonging to this order is known in half (15) of the discussed diseases and in 7 of them Artiodactyla are the main hosts. Alongside of rodents, Artiodactyla among mammals are the main consumers of vegetable forage and produce a considerable part of the biomass of mammals. Numerous species belonging to this order are herd animals which form accumulations within a confined space. At first Artiodactyla were the main objects of hunting, subsequently they have been domesticated providing animal proteins and fats (meat and milk) to people. In some areas artiodactyla are widely used as draught cattle. A number of diseases which in recent past were considered to be natural foci diseases, have become (anthrax, brucellosis) or are now becoming (Q-fever, leptospirosis) predominantly diseases of domestic animals. The diseases of Artiodactyla are characteristic of massive contamination with the pathogen of the environment, and of various routes of transmission among which the alimentary is predominating. The diseases of Artiodactyla are also spread by the transmissive way—mainly by the blood-sucking Diptera (African trypanosomiasis, anthrax). The paramount importance of Artiodactyla diseases in human infectious pathology is explained mainly by the great volume and duration of man's contact with these animals.

Natural infection of carnivores is known in 18 out of the 30 diseases discussed, but only in 3 diseases—rabies, leptospirosis and visceral leishmaniasis they are involved as main hosts. Predators are relatively resistant to most pathogens and are involved in the chain of the circulation, usually as additional links. They come into contact with the infection while pursuing and devouring animals, sick with or perished from animal diseases. The infection, however, sets in only when a large quantity of prey tissues saturated with the pathogen is ingested. The mechanism of transmission of diseases, in which carnivores are the main hosts is not uniform. The virus of rabies is passed to animals by bites, visceral leishmaniasis is transmitted by sandflies, while leptospirosis is spread among predators by sexual way.

The role played by carriers of the diseases transmitted to man is somewhat smaller among Lagomorpha, Insectivora, Marsupialia and Primates. The order Lagomorpha consists only of 63 recent species. Its representatives, at present, inhabit all continents but the Antarctica. Many species are known for a large number of individuals. These animals in some regions belong to the main consumers of vegetable forage and serve the purpose of hunting. Natural infection of Lagomorpha is known in 14 of the discussed diseases and only in 4 of them these animals are the main hosts. It is noteworthy that the main hosts for the same diseases are Rodentia (plague, tularemia), Artiodactyla (brucellosis) or both mentioned orders (tick-borne encephalitis). There is no specific route of transmission of the pathogen which is peculiar mostly to the Lagomorpha species.

Insectivora is an order with a great variety of species (406) and a considerable number of representatives. Natural infection with this order is known in 14 diseases, but only in 3 of them the representatives of this order are the main hosts. Two diseases are contracted by these animals as a result of contacting soil contaminated with the pathogen (erysipeloid, leptospirosis) and one (tick-borne encephalitis) is transmitted by ticks. It should be noted that the true role of Insectivora in the circulation of the tick-borne encephalitis virus lacks sufficient clarity.

Marsupialia is one of the oldest groups of mammals with a limited range in present conditions. This order is distinguished by richness in species (242), a diversity of life forms and large numbers of individuals in some of its groups. Natural infection of the

representatives of this order has been established in 8 diseases and in 3 of them marsupials are the main hosts. Three diseases (leptospirosis, Q-fever and the Chagas' disease) are characterized by an extremely wide range of hosts. Their main carriers belong to 4—5 orders of mammals.

Primates are characterized by a moderate number of species (166). In some places they are rather numerous, mostly they live in trees. Primates have been registered as carriers of 7 diseases dangerous to man. The representatives of Primates are the main hosts of 2 diseases: yellow fever and the Kyasanur Forest disease. The former is a specific disease of Primates, the range of the main hosts of the latter has not been elucidated as yet.

The diseases which are common in Chiroptera and man are few though this order holds the second place by the number of species (875) and is noteworthy for the abundance of representatives. Chiroptera are among the main hosts in rabies only and in several arboviruses, whose real importance in human pathology is unknown. All diseases of Chiroptera are transmitted by bites.

The species belonging to Pinnipedia, Mysticeti, Odontoceti, Sirenia have served the purpose of mass hunting for a long time. People come into close contact with animals in dressing and utilising their carcasses. However, carriers of facultative parasites of animals and man—*Erysipelothrix rhusiopathiae* are known only among the representatives of the orders of Pinnipedia and Odontoceti. This causative agent is distinguished by an extremely wide range of hosts: mammals, birds, reptiles, fishes. It can multiply in humid soil rich in organic remains. The sea lion had once been found to carry leptospirosis. However, human infection with leptospirosis from Pinnipedia has not been described. These facts exhaust the information on the carriage of diseases dangerous to man by aquatic mammals.

The information is conducive to several preliminary conclusions of those features of the mammal orders which predetermine their role as hosts of diseases dangerous for people. Primarily it is the environment where they live; the water forms practically do not have diseases in common with man. As for the species which procure their feed in the air during flight, they are afflicted with a minimal number of such diseases. Practically the same applies to species which spend most of their lives in trees.

The second place goes to the ecologic characteristics of the order. The number of representatives is an essential factor as well as their role in ecosystems, diversity, the regularity and the intensity of contacts with man.

The species' variety does not predetermine the importance of the order as carrier of human diseases. There is no correlation between the phylogenetic antiquity and the importance of either group of mammals as hosts of human diseases.

МЛЕКОПИТАЮЩИЕ НОСИТЕЛИ БОЛЕЗНЕЙ ОПАСНЫХ ДЛЯ ЧЕЛОВЕКА

В. В. Кучерук

Резюме. Дан анализ разных групп млекопитающих, вовлекаемых в циркуляцию возбудителей природноочаговых болезней.

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