

THE ROLE OF RODENTS IN THE TRANSMISSION OF VIRAL AND BACTERIAL DISEASES OF LIVESTOCK

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SUMMARY

Rodents are the most successful and abundant mammals on earth. The commensal behavior of some of the rodents has made them important in the epidemiology and ecology of many viruses and bacteria pathogenic to livestock and humans. Rodents may act as vectors, carriers, or passive (mechanical) transmitters of pathogens. Diseases actively transmitted by rodents may involve a territory, a region or even across continents as they observe no internationally recognized boundaries. These diseases may be classified as (a) those which affect rodents as well as other mammals (e.g. rabies, lymphocytic choriomeningitis, typhus, Q fever, plague, salmonellosis) (b) those for which rodents act as reservoirs and affects other mammals (e.g. leptospirosis, foot and mouth disease, African horse sickness, ehrlichiosis). Mechanical transmission of disease causing agent through rodents hairs, claws and mouthparts although frequent, is usually limited to a farm or a household. Certain pathogens (e.g. pox viruses, salmonella) and various fungal and bacterial spores may be transmitted this way. Rodents also act as intermittent hosts for arthropods and arachnids, which are themselves primary hosts for diverse parasitic microorganisms of animals and humans. This paper describes briefly, the most important livestock (and human) diseases of viral and bacterial origin which are transmitted directly or indirectly by rodents.

INTRODUCTION

Commensal rodents, mainly mice and rats, live at the expense of humans invading their homes, eating their food and damaging their properties. In addition, rodents play an important role in the epidemiology and ecology of major viral and bacterial diseases

of livestock and humans. Humans derive very little benefit from their existence. The most common rodent species which transmit disease are the Norway rat- *Rattus norvegicus*; the roof rat, *Rattus rattus* ; and house mouse, *Mus musculus*. Several other commensal rodents do exist but have more localized distribution.

They have taken advantage of commercial transport and trade routes and spread from their ancestral home in Asia moving outward as civilizations developed until they reached all the continents of the world.

Originally commensal rodents were considered to be household pests until in the 19th century when the role of the rat in the spread of plague was demonstrated then man realized that these pests were among his worst enemies. More attention was given to their control thus the Danes established the 1908 Danish Rat Law which although helped to reduce the population of the brown rat it failed to eradicate them. Since then other principles of rodent control have been established and are frequently under review in order to control the rodent as a pest and a disease vector.

Rodents' habits of gnawing at a wide range of objects, feeding mainly in the night, roaming everywhere contribute much to the transmission and dissemination of infectious agents from place to place. Furthermore, rodents have good senses of touch, smell and hearing which contribute to their survival even when numerous

campaigns to eradicate them are being mounted. They are highly adaptable to extreme weather conditions such as very low temperatures, or very hot climates. Being in abundance, they contaminate the environment with tons of faecal pellets and excrete millions of litres of urine which become useful in spreading pathogens. Their abundance and their presence everywhere offers a survival of vectors to pathogens such as flea and plaquea, mites, ticks and African swine fever virus.

Despite their hazardous nature, rodents are of importance to the world of science especially white mice, is reflected by their wide use in the study of diseases, the biology of the pathogens, and the effects of new pharmaceutical.

The role rodents play in the ecology and epidemiology of infections will be discussed under different categories namely; diseases which cause clinical condition in both livestock and rodents; diseases of which the rodents are reservoirs and/or maintenance host; diseases of which the rodents can act as mechanical transmitter and diseases transmitted indirectly by rodents through their harbouring the vectors.

DISEASES TRANSMITTED BY RODENTS

Diseases which cause clinical syndrome in livestock and rodents. Some pathogenic microorganisms affect a wide range of hosts including rodents. These include rabies virus, pseudorabies virus, cowdria, salmonella and leptospira.

Rabies is a rhabdovirus infection of the nervous system which may affect all mammals. This virus is normally transmitted by a bite from a rabid animal and usually, but not always, is manifested by a fatal encephalitis. Rabies in mice and rats has been reported from many countries but its actual contribution to the epidemiology of the disease has not been documented. Reports from Germany have indicated that in the period 1961-1967, 3 mice and 18 rats were found to be infected (Mesina and Campbell 1975). In 1968, a report from Thailand indicated that 4.7% of Norway rats were infected with rabies (Twigg 1980). Several cases of rabies in rodents were confirmed in 1980 and 1981 from South Carolina and Nebraska (USA) respectively (Steele 1973, Dowda et. al., 1981, Mortality report, 1981). Wrinkler (1972) concluded that rabies in rodents is rare in USA but each rodent bite should be evaluated because on average four to five

cases of rodent rabies per year were reported out of 25,000 rodents examined. To date little information is known regarding the role of commensal rodents in rabies transmission in countries where rabies is endemic. Therefore, more research is needed to establish the role of rodents in the transmission of rabies in collaboration with Human Medical Sections.

Aujezsky's disease (pseudorabies) is a viral condition caused by a herpesvirus, which affects a wide range of animals including swine, cattle, sheep, dogs, cats, and rats. It has been observed that rats suffer a high mortality rate immediately prior to an outbreak of pseudorabies in livestock. Pseudorabies is characterized by marked pruritis and death of the affected animals. Rats that survive natural or experimental infection harbour the virus for more than 131 days. In addition, the virus can remain viable in the carcasses of rats that have died of the infection for a month thus become a source of infection to livestock (Morbidity and Mortality Reports 1973, 1981).

Lymphocytic choriomeningitis (LMC) is a viral disease of rodents which is transmissible to humans. It is caused by an Arenavirus and characterized by a mild to fatal disease in man and rodents. Symptoms observed are fetal

damage in pregnant women, rhinitis, muscular pain, meningioencephalitis, drowsiness and paralysis. Rodents especially house mouse suffer a fatal disease and can transmit the virus vertically to its offsprings. This disease has been reported in the European and American continents. Young mice infected with the LCM virus may become latent carriers which play an significant role as reservoir of the virus. Foci of infection in mice may persist for a long period of time limited area, giving rise to sporadic human clinical cases. Therefore although the analysis of serum sample collected from Morogoro region showed negative results to arenaviruses antibodies, we cannot rule out the presence of arenaviruses in the area due to this latency (Armstrong et al., 1940, Skinner and Knight 1979, WHO 1987).

Query or Q fever is another disease which affect all mammals including man and birds. It is caused by a rickettsia, *Coxiella burnetti*. The disease is characterized by fever, vomiting, general weakness, pneumonitis and encephalitis in mammals and birds. Rats and mice suffer natural infection and many have been found to be seropositive to the Q fever agent thus can be source of infective rickettsiae to susceptible population (Burgher et al., 1963,

Yadar et al., 1979, Reisman et al., 1979, Sawyer et al., 1987).

Murine typhus is a rickettsial infection of man and rodents caused by *Rickettsia typhi* also known as *R. mooseri*. The organism's real vector is a rat flea, *Xenopsylla cheopis*, released through flea faeces. The disease is characterized by fever, prostration, spotted skin rash and myalgia. Humans and rats acquire the infection from direct contact with flea faeces through skin abrasions caused by the flea bite. Outbreak of this infection in man has been shown to be closely linked with the presence of commensal rats living indoor in urban environments and less so in rural areas (Traub et. al., 1978).

Rickettsialpox is a mite-borne rickettsial infection of human and mice characterized by initial development of papular lesions at the site of mite bite followed by an extensive varicelliform rash, fever, malaise and myalgia. Mite associated with this condition is *Liponyssoides sanguineus*, the mouse mite, which spread the disease from mouse to man and from mouse to mouse. The house mouse, *Mus musculus* is the main host of this mite in USA and the Norway rat, *Rattus norvegicus*, the main host in USSR (Huebner et. al., 1946).

Rodents are also commonly infected with Salmonellae, especially *Salmonella typhimurium* and *S. enteritidis*. Certain salmonella serotypes can cause mortality in rodents. Salmonellosis in humans and livestock is characterized by abdominal pain, acute gastroenteritis, diarrhoea, vomiting and fever. Rats and mice can spread the infection to humans and livestock through infected faecal droppings and urine which can contaminate foods or food preparation surfaces in bakeries, kitchens, markets, and restaurants. In the study conducted in Morogoro, 129 rats were trapped around SUA campus. All were of the species, *Praomys natalensis* except one which was *Lemniscoury grisella*. Out of the 129 sampled rats, only two were found to be infected with *S. typhimurium* and one with *S. amager*. Thus the infection rate was (2.3%) higher than reported by Welch and his colleagues in 1941 which was 1.8%. However, higher infection rates have been reported elsewhere. Zwart (1962) found infection rate of 8.6% in Ghanian rodents and Kayihura (1982) 7.3% in Kenyan rodents. Guinee and others (1963) found that infection rate was 4.0% for rats on the farms; 17.8% for rats in slaughter houses; and 30.8% for rats in mink farms. They therefore, concluded that salmonella infection rates correlated with the

rate environmental contamination. Despite the low infection rates there is the potential danger of contaminating pastures, foodstuff, and drinking water (Jones and Twigg 1976).

Plague is a highly fatal bacterial disease of man and rodents which is caused by *Yersinia pestis*. It is primarily a disease of rodents transmitted between them by bites of infected fleas. However, when rodent population is drastically reduced infected fleas seek other warm-blooded host to feed on. Human beings become a target and thus acquire the infection through infected fleas (WHO, 1987). Plague has been reported to be endemic in Lushoto district in Tanzania and a project is underway to study the epidemiology of the disease in this area (Kilonzo et.al, 1992). Rodents are also capable of transmitting other *Yersinia* species, such as *Y. enterocolitia* which cause acute diarrhoea condition in humans (Isaacson 1981, WHO 1987)

Diseases of which the rodents are reservoir and or maintenance host.

There are several diseases of livestock and humans of which rodents act as symptomless carriers and allow multiplication and existence of the aetiological agents in their body systems thus becoming source of renewed

infection to clean population. Often, existence of infectious agents in rodents is demonstrated only by presence of antibodies, however, in certain latent infections state there may be no obvious indicators.

African horse sickness and blue tongue disease are both caused by viruses belonging to the orbivirinae of the Reoviridae which affect horses and sheep respectively. These two diseases are transmitted by arthropods mainly *Culicoides* but in between outbreaks the virus may disappear. It is believed that a wild host reservoir possibly the rodents may harbour the virus in the quiescent period (Buxton and Fraser 1977, Scott 1990).

Rift valley fever is a highly contagious disease of sheep, goat, cattle and humans which is transmitted by mosquitoes, *Aedes spp.* and *Culex spp.* This disease is characterized by abortion in pregnant ewes and cows, heavy mortality in young lambs and calves. Experimentally, the virus infect mice, rats, and hamsters indicating the potential role of rodents as reservoir or maintenance host (Weber 1980).

Similarly, ephemeral fever virus can infect mice under laboratory conditions. Ephemeral fever is a rhabdoviral infection of cattle

characterized by sudden onset of fever, stiffness, lameness, and spontaneous recovery. It is naturally transmitted by ticks (Buxton & Fraser 1977).

Newcastle disease (ND) is a paramyxovirus infection of poultry characterized by pneumonia, encephalomyelitis, enteritis and conjunctivitis. The virus was isolated in the house mice, *Mus musculus* captured around chicken houses in California in 1974. Also, when mice were infected by the ND virus in the laboratory, the virus could be recovered from them for 9 days thus suggesting that ND can be transmitted by mice during outbreaks since chickens tend to peck on mice that come into their vicinity. This area needs further investigation as ND has been difficult to eradicate despite the regime of vaccination used in Tanzania. In Morogoro it has been observed to have a seasonal occurrence. The reservoir of the virus during the quiescent period is not known and needs to be investigated (Walker 1950, Baczigishi 1959).

Foot and mouth disease (FMD) virus belonging to the picornaviridae causes a disease of major economic importance because of the speed with which it spreads through animal populations and the heavy losses it causes in milk production and

deaths among calves. Capel-Edwards (1971) found out that the Norway rats are susceptible to the virus and develop antibodies to it. The rats were also found to excrete the virus for several months after laboratory infection. The continued excretion of the virus, the close associations of rats with farm animals and the rats' ability to migrate considerable distances may be significant factors in the epidemiology of FMD. Studies conducted in New Zealand have shown that rats e.g. *R. rattus* and *Hydromys chrysogaster* are susceptible to FMD virus (Capel-Edwards 1971).

Duck hepatitis is a viral disease caused by Hepadnavirus which was first described in 1950, as causing severe losses in young ducklings in USA. Ever since, it has been reported in most of the important duck-growing areas of the world. The virus causing the condition belongs to hepadnaviridae. Research done in USSR indicated that the Norway rats are capable of acting as a reservoir host for the virus since it remains viable in the rats for up to 35 days and excrete the virus through faeces and urine for 22 days (Howard and Zuckerman 1990).

Encephalomyocarditis (EMC) is a picornaviridae disease of pigs, cattle and man characterized by

meningitis, depression, ataxia and high mortality in young pigs. Studies carried out in USA and elsewhere have indicated that the EMC virus is harboured in rats and other rodents which then disseminate it through urine and faeces (Mesina and Campbell 1975, Carter and Cordes 1980).

Lassa fever is an acute arenaviridae disease of man characterized by fever, headache, sore throat, cough, vomiting, diarrhoea, myalgia, chest and abdominal pain. Swelling of lymph nodes, face, neck and conjunctivitis are often present. This disease was first reported in Nigeria in 1969 (Frame et al., 1970) and ever since it has been diagnosed in other western and central African countries (Monath 1975). Lassa fever virus belongs to the Arenaviridae group which consists of viruses causing haemorrhagic fevers in man. The multimammate rat, *Mastomys natalensis*, is a primary reservoir host of Lassa fever virus. It sheds the virus in the nasal secretions, faeces and urine from which man can pick the infection. Humans can also acquire the fever through contact with an infected man.

Other arenaviruses harboured by rodents and known to cause haemorrhagic infection in man are: Bolivian haemorrhagic fever transmitted by house mouse,

Calomys callous; Argentinian haemorrhagic fever transmitted by mouse, *Calomys laucha*; Korean haemorrhagic fever transmitted by field mice. The mice also serve as reservoir host of these viruses (Jawetz *et al.*, 1989, Stuart-Harris 1990).

Some other viral diseases of human beings for which rodents can be either reservoir host or maintenance host are banzi, Colorado tick fever, Crimean-Congo haemorrhagic fever, Japanese B encephalitis, Kyasanur forest disease, Powassan encephalitis and St Louis encephalitis. All the viruses causing these conditions are arthropod-borne and rodent-borne (Weber 1980, Jawetz *et al.*, 1989, Stuart-Harris 1990).

Kenya tick typhus is a rickettsial infection transmitted by rodents. It is caused by *R. coronii*, and the disease is characterised by a small ulcer at the site of the tick bite which is then followed by fever, joint and muscle pains, and severe headache. This rickettsia also affects cattle, swine, dogs and cats causing a mild disease. Rats and mice are host of the ticks which transmit the rickettsia. Tick species implicated are *Haemaphysalis leachi*, *Rhipicephalus sanguineus*, *Amblyomma spp.*, *Ixodes spp.* and *Dermacenter spp.* All are three host

ticks and are capable of transmitting the rickettsia transovarially. The most notorious species are the multimammate mouse, house mouse, grass mouse, black roof rat, house rat, and grass rat (Gear 1954; Brezina *et al.*, 1973; Woodward, 1973; Jawetz *et al.*, 1989).

Rocky mountain spotted fever is a mild to severe febrile disease of man and animals caused by *Rickettsia rickettsii*. It is an very important tick-borne rickettsiosis of humans that causes considerable loss of life in the American continents. The tick vector involved is *Dermacenter spp.*, *Amblyomma spp.*, *Haemaphysalis spp.* and *Rhipicephalus sanguineus*. These species are all three host ticks and are capable of transmitting the infection transovarially. The causal rickettsia have also been isolated from several rats and mice implicating them as reservoirs of the infection (Hoepflich 1977, Hechemy 1979; Jawetz *et al.*, 1989):

Scrub typhus and North Asian tick typhus are two conditions caused by *Rickettsia tsutsugamushi* and *R. sibirica* respectively occurring in the Asian subcontinent. They are diseases of man transmitted by mites (scrub typhus) and ticks. Both diseases are characterized by fever, severe headache, lymphadenopathy and a red rash.

A primary lesion appear at site of the mite or tick bite. Mice and rats are known to harbour the rickettsial organisms thus acting as reservoirs for the pathogen. The mite responsible for transmitting scrub typhus in man is *Leptotrombinium spp.* *Dermacenter spp.* are the tick- vectors of Asian typhus (Berman and Kundin 1973; Jawetz et al., 1989).

Leptospirosis is an important bacterial disease of humans, cattle, pigs, and dogs. It is caused by spirochaetes which live in the kidneys of rats and are shed in urine. Leptospirosis is a serious disease, characterized by fever, vomiting, meningitis jaundice and renal failure. Humans may contact the disease from rodents, soil, or directly from infected animals (cattle, pigs, and dogs.) or through swimming or working in contaminated water or soils (Bey et.al.,1986, WHO 1987, Machang'u 1991).

Rat-bite fever is a bacterial infection of humans caused by *Spirillum minus* and *Streptobacillus moniliformis*. These two bacteria are carried in the upper respiratory tract of wild and laboratory rats, squirrels and weasels. The disease is characterized by fever arthritis and endocarditis in humans. This is something the rodent catchers should be aware of (Jawetz et al., 1989). Diseases of which rodents

can act as mechanical transmitter.

Many disease causing agents that survive in the environment are easily picked up by rodents on their body surface and transmitted to a susceptible host or introduced in a new environment. Fowl pox is one example of an of the pox infection easily transmitted by rodents. It is a pox infection of chicken characterized by proliferative lesions on the skin or mucus membrane of the mouth and upper respiratory tract. Rats readily transmit the fowl pox virus on their fur and foot pads. Likewise, pox viruses of sheep, goats and cattle can be carried from one locality to another by rats and mice. Bacterial and fungal spores can easily be carried by rodents from one locality to another (Tripathy and Cunningham 1984). Diseases transmitted indirectly by rodents through harbouring the vectors.

Rodents may contribute to the epidemiology of many infectious diseases through harbouring the vectors responsible for the continue existence of the disease. Many blood-sucking arthropods and arachnids will feed on rodents when the preferred host is not available, thereby ensuring their survival. Some of these arthropods and arachnids are disease vectors thus the disease continue. Such diseases include viral

encephalitides, viral hemorrhagic fevers, African swine fever, African horse sickness, blue tongue, lumpy skin disease and many rickettsia causing typhus (Rweyemamu, 1981, Jawetz *et al.*, 1989).

CONCLUSION

Rodent-borne diseases for livestock and humans are numerous and only the most important ones have been discussed in this review. It is quite obvious that rodents play a crucial role in the epidemiology of these diseases and in the ecology of the transmitting agents of diseases. Rodents are not only pests but are health hazards. It is important therefore that serious measures must be taken to control rodents.

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