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The First Animal disease to be Eradicated in the History of Pandemic-RINDERPEST

Nakshe R Jain [1*],

[1] Assistant Professor, Head, Department of History Maharani Lakshmi Ammanni College for Women Autonomous, Bengaluru City University *** Corresponding author email address**:rnakshe@gmail.com

Abstract

The history of the world is marked by several devastating pandemics that have affected both humans and animals. While many pandemics such as the Plague of Justinian, Black Death, Spanish flu, SARS, swine flu, MERS, and COVID-19 have had a major impact on the human population, animals have also suffered from pandemics such as Rinderpest, Avian Influenza, and Foot and Mouth Disease Virus. This paper will provide a brief overview of the Rinderpest virus, also known as the "Cattle Plague," which was a highly contagious and devastating disease of livestock that caused famine and poverty across continents. In 2011, the Rinderpest virus was declared globally eradicated by the UN Food and Agriculture Organization and the World Organization for Animal Health, making it only the second disease to be eradicated after smallpox in humans. The paper will also explore the history of Rinderpest, including its origin, its spread as a pandemic, its symptoms, the efforts made by various organizations to eradicate it, and a conclusion on its impact on the world.

Keywords: Ebola, SARS, MERS, COVID-19, Rinderpest, Avian Influenza, Foot and mouth disease virus, zoonotic diseases, UN Food and Agriculture Organization, the World Organization for Animal Health

Introduction

Zoonoses or Zoonotic diseases

The word Zoonoses is derived from the Greek word,

_Zoo‘ means animal; _Noses‘ means diseases. Zoonotic diseases constitute a unique group of infectious diseases that affect man as well as animals (1). The word _zoonosis‘ was first coined by Rudolph Virchow, one of the most prominent physicians, German pathologist of 19th century. He coined to indicate an infectious disease that is passed between humans and animals. Since Rudolf Virchow, the list of zoonotic diseases continues to expand. More than 200 types of diseases are recognized as zoonoses. Major modern diseases such as Ebola virus and Salmonellosis are zoonoses (1)(2).

The Joint Expert Committee of WHO and FAO (1959) has defined zoonoses as _those diseases and infections which are naturally transmitted between vertebrate animals and man‘ (1).

Zoonoses are the most significant and biologically heterogeneous group of communicable diseases that caused by different groups of pathogens (an infectious agent such as bacterial, virus or parasite or prion) that can spread to humans through direct contact or through food and water. They represent a major public health around the world due to our close contact with animals in agricultural, as companions and in the natural environment. Zoonoses can also cause disruptions in the production and trade of animal products for food and other uses. For example, Avian influenza. The animal host gets sick because of such diseases. Other zoonotic diseases, including Ebola, an animal carries the virus but is not sickened by it. The

Zoonotic diseases constitute an unique group of infectious diseases that affect man as well as animals.

Sources: OIE

animal host gets sick because of such diseases.

Other zoonotic diseases, including Ebola, an animal carries the virus but is not sickened by it. This makes it difficult to trace which animal is hosting the diseases. An animal that carries these diseases to humans is known as a reservoir host. Even after the virus has infected humans, it remains a reservoir host. Many other zoonotic diseases that caused the pandemic were rinderpest virus, food-and-mouth disease virus, etc. (1)

The procedure Pathogen cross-species transmission happens in five stages: (a) the pathogen only infects animals under natural settings; (b) the virus evolves so that it can be transmitted to humans but without sustained human-to-human transmission; (c) the pathogen undergoes only a few cycles of secondary transmission between humans; (d) the disease exists in animals but extended sequences of secondary human-to-human transmission occur without the participation of animals; (e) the disease exists in animals but long sequences of secondary human-to-human transmission occur (3)(12)

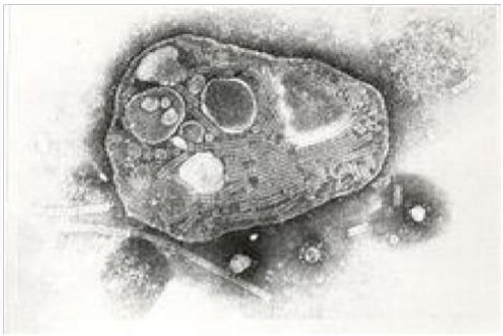
The transition from hunter-gatherer to agrarian communities has aided the spread of these deadly viruses. Domesticated, domiciled, wild and cold-blooded animals have played major role in transmission of zoonoses. In both urban and rural settlements, several animals are becoming household pets which could be a source of infections to their owners such as dogs and cats. Animals who live in close association with human dwellings such as rats, mice, rodents, etc., have played major role in transmission as well as maintained numerous zoonoses. For instances, bubonic plague, is an excellent example of such zoonoses. Animals have been providing numerous benefits to the human population. (4)(17).

They provide food, fiber, livelihood, sports, travel, companionship, and education across the world. The major causes are the increase in population density, inadequate sanitary measures, easy access to garbage and food material in urban area, improved methods of agriculture, decrease in number of their natural enemy especially in rural areas has resulted in severe increase in the population of these animals and the threat of spread of zoonotic diseases. These diseases may have expanded drastically because of greater contact with animals through hunting, animal farming, the sale of animal-based foods, wet markets, or the exotic pet trade, as well as daily life.

This paper will give a brief history on Rinderpest virus that afflicted animals throughout history. While it did not infect humans it severely affected their livelihoods. Infectious diseases has and will remain a threat throughout the globe. (4)

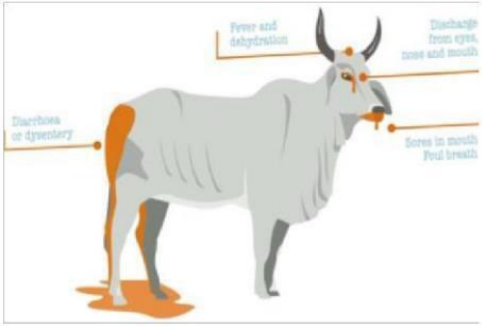
What is Rinderpest virus? (14)(15)(17)

Rinderpest is a German word and in English it is termed as ‗Cattle Plague'. It is caused by a morbillivirus of the family Paramyxoviridae, (1)(4) closely related to human measles virus. This virus could have led to the origin of measles virus when people started to domesticate cattle 10,000 years ago. With a 100% death rate in some herds, rinderpest can rapidly transmit among cloven-hoofed animals (mainly cattle and buffalo). It has been a dreaded cattle disease for millennia, causing massive losses to livestock and wildlife on three continents namely Africa, the Middle East and Asia. Recognize the disease- Classical symptoms of the disease in cattle, the most susceptible species, include fever, erosive lesions in the mouth, discharge from the nose and eyes, profuse diarrhea, and dehydration, which often leads to death within 10 to 15 days. Other species of rinderpest may exhibit milder clinical symptoms. Depression, discharges, diarrhea, and death, as well as fever (and/or mouth lesions), are common clinical signs. (5)



Rinderpest Morbillivirus

Sources: Wikipedia



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https://rinderpestvigilance.com/en/what-is-rinderpest/

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This deadly cattle plague triggered several famines and caused the loss of draught animal power in agricultural communities mainly in 18th, 19th, and 20th centuries. Three human activities were responsible in widespread of rinderpest from its origin; 1) rapid growth of human population with increase in dependency on cattle for food; draught power and finally the diseases firstly spread due to waging wars and secondly through trade if livestock. People cannot catch Rinderpest and most experts say that people suffer no harm from eating infected meat. However, once the cattle have all died out, the food supply disappears (6). The first animal disease to have been eradicated, rinderpest is highly contagious and has a long history of loss in animal population. The far-reaching consequences have led to the creation of World Organization for Animal Health (OIE), whose efforts have successfully helped in eradication of rinderpest in 2010, only the second disease to be eradicated in the world after smallpox.

History on Rinderpest

Rinderpest is said to be originated in Asia and later spread with transport of cattle from one region to another. According to Hebrew Bible, a cattle plague was thought to be one among the 10 plagues of Egypt. By 3000 BC, a cattle plague had reached Egypt, and rinderpest later spread throughout Africa, following European countries. Severus Sanctus Endelechius had described Rinderpest in his book, _On the Death of Cattle‘ (5).

The earliest recorded epidemic of the disease occurred between 376 - 386 AD (17). Aristotle had described a disease in cattle, struma that had similar characteristics of rinderpest and by the fourth century the disease was likely brought from European countries by the Huns and the Mongols who invaded from Central Asia resulted in outbreak of highly contagious disease which contained all the characteristics of rinderpest (5).

Panzootic of Rinderpest were brought with the invasion of Mongols in western Europe by thirteenth century. The Hun and Mongol invaders raiding as-far-as present-day Iraq and Austria, brought rinderpest to Europe from their homeland Central Asia. It is said that when the Mongol leader, Genghis Khan, invaded Europe in the 13th century, his cattle accidentally spread a disease known as Rinderpest. The deadliest virus can infect cattle, goats, bison, and giraffe. Genghis Khan spread the disease accidentally, but in modern warfare Canada, US and UK have considered spreading the disease on purpose as a bioweapon (6). They state that spreading a disease that affects livestock harms enemy in a similar way as spreading disease that affects crops. People reply on the animal source of food (6). As time flew these raids transformed into trading partnership. The Asian grey Steppe oxen were remarkable resistance to the effects of this disease, and large herds could shed the virus for months and provoked epidemic to the native cattle and buffalo herds (4). Repeated barbarian invasions introduced rinderpest into Europe responsible for massive human migrations that spread the disease widely. From seventeenth, eighteenth, nineteenth century onwards, the disease spread century on, the disease was spread to Western Europe through cattle trading, mainly from Russia to feed the growing European cities; at that time rinderpest was known as ―Russian Disease‖ in Russia. Russian Disease was not only spread by cattle traded for meat but also by corn trade that was transported in massive quality carried by Ox-drawn carts (7). In 1709, this disease again entered in Europe through Venetian trade. In an event, XIII oration delivered on November 23rd and 24th in 1711. On this occasion Bernardino Ramazzini, Professor of Medicine at Padua University pronounced ―far better to prevent than to cure‖. The oration describes a severe epidemic of rinderpest that struck the territory of the Venetian Republic in 1711(8).

Through venetian trade it spread as far as Britain in 1714. However, Johann Karol of Prussia, in 1711 recognized that rinderpest was transmissible and that cattle that recovered from it were resistant to reinfection. As previously mentioned, during the eighteenth century, numerous attempts were made to vaccinate the animals, but were unsuccessful. Devastating by the death of cattle population in Europe due to this disease, that the French king‘s controller of finances gave funds to Claude Bourgelat to establish the first veterinary school in Lyons, France in 1762(9). The need for this step was made apparent faced by the livestock plagues devastating Europe at that time. Other European countries followed the steps of French and established their own veterinary schools (7).

The nineteenth-century development of steam power enabled the shipment of live cattle by rail and sea in previously unimaginable quantities. As a result, rinderpest decimated Europe's cattle population in the mid-nineteenth century. During the early twentieth century, a massive trade of Baghdadli cattle into Egypt from Iraq was also notorious for introducing rinderpest without the imported cattle being seriously affected (8). War and civil unrest spread rinderpest until the late twentieth century: Israeli and

Syrian armies, withdrawing from Lebanon in the early 1970s, carried rinderpest with looted cattle into their own countries; goats were implicated in the unintended reintroduction of rinderpest to Sri Lanka in 1978 by Indian peacekeeping forces; civil unrest from the Gulf war in the 1990s there had been a significant rise in infectious disease in Turkey, Iran, and Iraq. These events were followed by endemic virus circulation in eastern African pastoral areas, with occasional outbreaks of disease caused by intertribal raiding, particularly among the Karamojong tribes living in Contiguous areas of conflict resolution in southern Sudan, Ethiopia, Kenya, and Uganda (9). Conflict resolution among these peoples became a major exercise and an important part of their lives. Conflict resolution among these peoples became a major exercise and an important last-mile effort in the rinderpest fight (4)(5)(10)(11).

In Africa south of the Sahara, rinderpest does not seem to have been known until a century ago (nagana, the disease transmitted by tsetse, is indigenous). Rinderpest was introduced into Sub- Saharan Africa with disastrous consequences in 1887 with cattle imported from India to Abyssinia (now Ethiopia) to feed Italian troops fighting a colonial war. The same year it reached Masai land and Uganda; never had cattle been known to die in such numbers. In 1892 it entered the country north of Lake Malawi and by 1896 was reported from both sides of the Zambezi and shortly afterwards from the Transvaal, Orange Free State, and Angola. When it arrived in Natal in 1896, it slaughtered more than 90% of all African-owned cattle. The virus then became endemic and spread throughout East African pastoral communities. Maurice Nicolle and Mustafa Adil Bey identified in 1902 that rinderpest was caused by a filterable agent, i.e., a virus. Next year it reached the southern tip of the continent. West Africa did not escape; thousands of pastoralists lost their entire herds in the 1890s and were forced to take up sedentary agriculture for at least a few years. Eventually the epidemic subsided in much the same way as an influenza epidemic. The panzootic spread to nearly all the parts of African continent within the span of 10 years, reaching South Africa in 1897. The devastation followed its path as it swept 90% of the domestic cattle and wild buffalo (Synceruscaffer) across the continent of Africa. This was called as ―Great African Pandemic‖ that caused major cultural, economic, and social upheaval. The disease raged uncontrollably across the African continent, causing massive famine, massive destruction, and the extinction of vast numbers of domestic and wild ungulates (11)(16).

An eminent microbiologist Robert Koch developed the first form of a rinderpest vaccine in 1897 while working in South Africa. He noted that the animals could be protected from the disease by Working in South Africa in 1897, eminent microbiologist Robert Koch created a vaccine containing bile from rinderpest-infected cattle that was administered subcutaneously. Koch demonstrated that the virus in bile is usually not infectious. Nonetheless, this was a risky procedure. Koch also demonstrated that immune serum provided short-term passive protection. A vaccine containing hyper immune serum and a virulent virus, on the other hand, producedlong-term strong immunity. For many years, this "serum-virus simultaneous" method was the most effective rinderpest vaccine, contributing to the disease's eradication in Europe in 1928(10).

The disease came back to Europe in the 1920s, when a herd of zebus was shipped from India to Brazil stopped in transit at the port of Antwerp. They infected cattle across Germany after encountering some imported American cattle sold in Belgian markets. This outbreak was contained through restrictions imposed on cattle movement, immediate slaughter, and vaccination. In France, an International Conference was held to which many countries were invited. In May 1921 a conference was held in Paris. The main objective was to establish an ‗international office of epizootics for control of infectious animal disease' be set up in Paris. (10)(4)(21).

Thus, on 25 January 1924, more than 20 years before the creation of United Nations, an agreement was signed by 28 countries from Europe, North and South America, Africa, and Asia to establish the OIE in Paris. As a result, the Office International des Epizooties (OIE)—now known as the World Organization for Animal Health—was established. This outbreak was controlled by restriction of cattle movement, immediate slaughter, and vaccination. As a result of this outbreak, it was decided to create the Office International des Epizooties (OIE)—now known as the World Organization for Animal Health.

In 1960 an English veterinary scientist, Dr. Walter Plowright, and his colleagues in Kenya were to develop an inactive vaccine- TCRV 9 tissue Culture Rinderpest Vaccine- that induced lifelong immunity without any major side effects. It was risk free from any kind of transmission and could be produced in low cost. Plowright was awarded with ‗World Food Prize' in 1999 for making rinderpest's ―eradication, for the first time in human history, a practical objective‖. Although the virus was virulent in the beginning, it quickly became less so, and after 95 passages, it no longer caused a fever in cattle and could induce long-term strong immunity. This vaccine provided lifelong immunity and had few side effects.

Rinderpest disease has been existing in India since 1900. Effects to control and eradicate the disease have consistently been made in the past. In 1964-1965 there was severe epizootic in India which culminated a death toll of 70 percent of animal population. Despite national eradication program launched during 1992-1993, with the assistance of EFC, the disease has not completed been eradicated from India, Pakistan, and Nepal. Status of rinderpest in different states of India has been reported on

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based on relative risk. Low risk zone below 1.0, medium risk zone 1.0 to 2.0 and High-risk zone 2.0 and above. The relevance of the disease has been recorded to be 10% 1963, 57.5% in 1963 to 1974 to 1998 (4)(9).

Final Steps to Eradication of Rinderpest: (9)

Eradication in Asia		
India	**2004**	The Asian countries mentioned were declared free from infections and in May 2011 all received accreditation and the OIE stamp of approval.
Pakistan	**2007**	
China	**May 2008**	
Afghanistan	**2007**	
Tajikistan	**2007**	
Uzbekistan	**2008**	
Kazakhstan	**2011**	
Sri Lanka	**2011**	

Eradication in Near East (9)		
Turkey	**2005**	In the middle region, the cases had not been reported more than 10 years prior to GREP deadline in 2010 and most were accepted as infection-free before that year. All have accorded accreditation in May 2011.
Iraq	**2009**	
Iran	**2008**	
Oman	**2009**	
Jordan	**2008**	
Lebanon	**2008**	
Saudi Arabia	**2011**	
United Arab Emirates	**2011**	

Eradication in Africa – African Lineage 1 Rinderpest Virus (9)		
Ethiopia	**African Lineage Rinderpest Virus presisted until 1995.**	OIE provided evidences that all were free from Rinderpest. In May 2011, they all were granted accreditation.
Sudan	**2001**	
West and Central Africa		
Northern and Southern Africa with exception of Egypt (last outbreak 1987)		
Comoros		
Liberia		
Sao Tome		
Sierra Leona		

Eradication in Somalia Ecosystem in Africa- African Lineage II Rinderpest Virus (9)(10)(7)

The strains of African Lineage II Rinderpest Virus were thought to be endemic in Somalia Ecosystem, covering areas of Southern Somalia and parts of Ethiopia and Kenya. The last rinderpest outbreak was in Kenya in 2001. However, with the help of SEREC – Somalia Ecosystem Rinderpest Eradication Coordination Unit, working along with GREP, provided evidence of rinderpest virus circulation. The last known outbreak in Kenya was reported Rinderpest free in 2001. Based on the above stats, by the end of 2010 FAO was confident to announce that all countries were Rinderpest free except those preserved in Laboratories (13).

Eradication in Somali Ecosystem in Africa- African Lineage II Rinderpest Virus (9)		
Ethiopia	**2008**	OIEprovided evidence that all were free from Rinderpest. In May 2011, they all were granted accreditation
Kenya	**2009**	
Somalia	**2010**	

Conclusion

Over the last century, national, regional, and international programs have aimed to eradicate rinderpest (19). When the FAO (13) was first created in 1945, one of its goals was to eradicate the virus. The disease was widespread around the turn of the twentieth century on three continents: Africa, Asia, and Europe. It caused the extinction of millions of cattle, buffalo, and other vulnerable animals, as well as the loss of people's assets, livelihoods, and ability to fend off famines. The last rinderpest outbreak was in Kenya in 2001 with the last case recorded in Mauritania in 2003 and the last time the vaccine was used was in 2006. There was no indication of virus circulation despite extensive illness searches and thorough serological surveillance across Asia, Africa, and the Middle East. Other elements of other surveillance components were employed to confirm that the disease did not exist in cattle and susceptible species in previously uninfected countries. Over next 10 years GREP (9) continued to search for rinderpest samples but finding none, on May 25, 2011, Rinderpest was declared eradicated by World Organization for Animal Health (OIE) (10). A resolution announcing global freedom from Rinderpest and the implementation of the follow-up measures to maintain world free from Rinderpest was adopted on 28th June 2011 in 37th FAO Conference. (20)

PROGRESS TOWARDS RINDERPEST GLOBAL FREEDOM (9)(18)		
Last outbreak	**2001**	In May25, 2011
Vaccination stopped and provisional freedom from Rinderpest	**2002** **2003** **2004** **2005** **2006**	Rinderpestwas declared eradicated by World Organization for AnimalHealth (OIE)
Targeted surveillance exercise	**2007** **2008** **2009**	
End of the field operations	**2010**	
Global Declaration	2011	

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