

Rinderpest

Rinderpest (also **cattle plague** or **steppe murrain**) was an infectious viral disease of cattle, domestic buffalo, and many other species of even-toed ungulates, including buffaloes, large antelope and deer, giraffes, wildebeests, and warthogs.^[1] The disease was characterized by fever, oral erosions, diarrhea, lymphoid necrosis, and high mortality. Death rates during outbreaks were usually extremely high, approaching 100% in immunologically naïve populations.^[2] Rinderpest was mainly transmitted by direct contact and by drinking contaminated water, although it could also be transmitted by air.^[3] After a global eradication campaign, the last confirmed case of rinderpest was diagnosed in 2011.^[4]

On 14 October 2010, the United Nations Food and Agriculture Organization (FAO) announced that field activities in the decades-long, worldwide campaign to eradicate the disease were ending, paving the way for a formal declaration in June 2011 of the global eradication of rinderpest.^[5] On 25 May 2011, the World Organisation for Animal Health announced the free status of the last eight countries not yet recognized (a total of 198 countries were now free of the disease), officially declaring the eradication of the disease.^[6] In June 2011, the United Nations FAO confirmed the disease was eradicated, making rinderpest only the second disease in history to be fully wiped out (outside laboratory stocks), following smallpox.^[7]

Rinderpest is believed to have originated in Asia, later spreading through the transport of cattle.^[8] The term *Rinderpest* is a German word meaning "cattle-plague".^{[1][8]} The rinderpest virus (RPV) was closely related to the measles and canine distemper viruses.^[9] The measles virus emerged from rinderpest as a zoonotic disease between 1000 and 1100 AD, a period that may have been preceded by limited outbreaks involving a virus not yet fully acclimated to humans.^[10]

Rinderpest virus (RPV)



Virus classification

Group:	Group V ((-)ssRNA)
Order:	<i>Mononegavirales</i>
Family:	<i>Paramyxoviridae</i>
Genus:	<i>Morbillivirus</i>
Species:	<i>Rinderpest morbillivirus</i>

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Virus

Rinderpest virus (RPV), a member of the genus *Morbillivirus*, is closely related to the measles and canine distemper viruses.^[9] Like other members of the *Paramyxoviridae* family, it produces enveloped virions, and is a negative-sense single-stranded RNA virus. The virus was particularly fragile and is quickly inactivated by heat, desiccation and sunlight.^[11]

Measles virus evolved from the then-widespread rinderpest virus most probably between the 11th and 12th centuries.^[10] The earliest likely origin is during the seventh century; some linguistic evidence exists for this earlier origin.^{[12][13]}

Disease

Death rates during outbreaks were usually extremely high, approaching 100% in immunologically naïve populations.^[2] The disease was mainly spread by direct contact and by drinking contaminated water, although it could also be transmitted by air.^[3]

Initial symptoms include fever, loss of appetite, and nasal and eye discharges. Subsequently, irregular erosions appear in the mouth, the lining of the nose, and the genital tract.^[2] Acute diarrhea, preceded by constipation, is also a common feature.^[3] Most animals die six to twelve days after the onset of these clinical signs.^[2]



A cow with rinderpest in the "milk fever" position, 1982.

History

Origins

The disease is believed to have originated in Asia, later spreading through the transport of cattle.^[8] Other cattle epizootics are noted in ancient times: a cattle plague is thought to be one of the ten plagues of Egypt described in the Hebrew Bible. By around 3,000 BC, a cattle plague had reached Egypt, and rinderpest later spread throughout the remainder of Africa, following European colonization.^[8]

Epizootics

Cattle plagues recurred throughout history, often accompanying wars and military campaigns. They hit Europe especially hard in the 18th century, with three long panzootics which, although varying in intensity and duration from region to region, took place in the periods of 1709–1720, 1742–1760, and 1768–1786.^[14] There was a major outbreak covering the whole of Britain in 1865/66. An outbreak in the 1890s killed an estimated 80 to 90% of all cattle in eastern and southern Africa, as well as in the Horn of Africa. Sir Arnold Theiler was instrumental in developing a vaccine that curbed the epizootic. The loss of animals caused famine which depopulated sub-Saharan Africa, allowing thornbush to colonise. This formed ideal habitat for tsetse fly, which carries sleeping sickness, and unsuitable for livestock.^[15] A more recent rinderpest outbreak in Africa in 1982–1984 resulting in an estimated US\$2 billion in stock losses.^[16]



Rinderpest outbreak in 18th-century Netherlands

Inoculation

In the early 18th century, the disease was seen as similar to smallpox, due to its analogous symptoms. The personal physician of the Pope, Giovanni Maria Lancisi, recommended the slaughter of all infected and exposed animals. This policy was not very popular and used only sparingly in the first part of the century. Later, it was used successfully in several countries, although it was sometimes seen as too costly or drastic, and depended on a strong central authority to be effective (something which was notably lacking in the Dutch Republic). Because of these downsides, numerous attempts were made to inoculate animals against the disease. These attempts met with varying success, but the procedure was not widely used and was no longer practiced at all in 19th-century Western or Central Europe. Rinderpest was an immense problem, but inoculation was not a valid solution: In many cases, it caused too many losses. Even more importantly, it perpetuated the circulation of the virus in the cattle population. The pioneers of inoculation did contribute significantly to knowledge about infectious diseases. Their experiments confirmed the concepts of those who saw infectious diseases as caused by specific agents, and were the first to recognize maternally derived immunity.^[9]



Cows dead from rinderpest in South Africa, 1896

Early English experimentation

The first written report of rinderpest inoculation was published in a letter signed 'T.S.' in the November 1754 issue of *The Gentleman's Magazine*.^[9] a widely read journal which also supported the progress of smallpox inoculation. This letter reported that a Mr Dobsen had inoculated his cattle and had thus preserved 9 out of 10 of them, although this was retracted in the next issue, as it was apparently a Sir William St. Quintin who had done the inoculating (this was done by placing bits of material previously dipped in morbid discharge into an incision made in the dewlap of the animal). These letters encouraged further application of inoculation in the fight against diseases. The first inoculation against measles was made three years after their publication.^[9]

From early 1755 onwards, experiments were taking place in the Netherlands, as well, results of which were also published in *The Gentleman's Magazine*. As in England, the disease was seen as analogous with smallpox. While these experiments were reasonably successful, they did not have a significant impact: The total number of inoculations in England appears to have been very limited, and after 1780, the English interest in inoculation disappeared almost entirely.^[9] Almost all further experimentation was done in the Netherlands, northern Germany and Denmark.

Further trials in the Netherlands

Due to a very severe outbreak at the end of the 1760s, some of the best-known names in Dutch medicine became involved in the struggle against the disease. Several independent trials were begun, most notably by Pieter Camper in Groningen and Friesland. The results of his experiment in Friesland were encouraging, but they proved to be the exception: testing by others in the provinces of Utrecht, Leeuwarden and Friesland obtained disastrous results. As a result, the Frisian authorities concluded in 1769 that the cause of rinderpest was God's displeasure with the sinful behavior of the Frisian people, and proclaimed 15 November a day of fasting and prayer. Interest in inoculation declined sharply across the country.^[9]

In this climate of discouragement and scepticism, Geert Reinders, a farmer in the province of Groningen and a self-taught man, decided to continue the experiments. He collaborated with Wijnold Munniks, who had supervised earlier trials. They tried different inoculation procedures and a variety of treatments to lighten the symptoms, all of them without significant effect. Although they were not able to perfect the inoculation procedure, they did make some useful observations.^[9]

Reinders resumed his experiments in 1774, concentrating on the inoculation of calves from cows that had recovered from rinderpest. He was probably the first to make practical use of maternally derived immunity.^[9] The detailed results of his trials were published in 1776 and reprinted in 1777. His inoculation procedure did not differ much from what had been used previously, except for the use of three separate inoculations at an early age. This produced far better results, and the publication of his work renewed interest in inoculation. For the period of 1777 to 1781, 89% of inoculated animals survived, compared to a 29% survival rate after natural infection.^[9]

In the Netherlands, too, interest in rinderpest inoculation declined in the 1780s because the disease itself decreased in intensity

In other countries

Apart from the Dutch Republic, the only other regions where inoculation was used to any significant level were northern Germany and Denmark. Experiments started in Mecklenburg during the epizootic of the late 1770s. 'Insurance companies' were created which provided inoculation in special 'institutes'. Although these were private initiatives, they were created with full encouragement from the authorities. Even though neighboring states followed this practice with interest, the practice never caught on outside Mecklenburg; many were still opposed to inoculation.^[9]

While some experimentation occurred in other countries (most extensively in Denmark), in the majority of European countries, the struggle against the disease was based on stamping it out. Sometimes this could be done with minimal sacrifices; at other times, it required slaughter at a massive scale.^[9]

In 1917-18, Dr. William Hutchins Boynton (1881-1959) the chief veterinary pathologist with the Philippine Bureau of Agriculture developed an early vaccine for rinderpest, based on treated animal ~~gan~~ extracts.^{[17][18]}

In ethnography

In his classic study of the Nuer of southern Sudan, E. E. Evans-Pritchard suggested rinderpest might have affected the Nuer's social organization before and during the 1930s. Since the Nuer were pastoralists, much of their livelihood was based on cattle husbandry, and bride-prices were paid in cattle; prices may have changed as a result of cattle depletion. Rinderpest might also have increased dependence on horticulture among the Nuer.^[19]

Vaccination

Dr Walter Plowright was awarded the World Food Prize in 1999 for developing a vaccine against rinderpest. Development work on the Plowright vaccine for the RBOK strain of the rinderpest virus lasted from about 1956 to 1962.^[20]

In 1999, the FAO predicted that with vaccination, rinderpest would be eradicated by 2010.^[21]

Eradication

Widespread eradication efforts took place as soon as the early 1900s; in 1924, the World Organisation for Animal Health (OIE) was formed in response to rinderpest.^[22] Until the mid-1900s, eradication efforts largely took place on an individual country basis, using vaccination campaigns.^[22] In 1950, the Inter-African Bureau of Epizootic Diseases was formed, with the stated goal of eliminating rinderpest from Africa.^[22] During the 1960s, a program called JP 15 attempted to vaccinate all cattle in participating countries; by 1979, only one of the countries involved, Sudan, reported cases of rinderpest.^[22]

In 1969, an outbreak of the disease originated in Afghanistan, travelling westwards and promoting a mass vaccination plan, which, by 1972, had eliminated rinderpest in all areas of Asia except for Lebanon and India; both countries were the site of further occurrences of the disease in the 1980s.^[22]

During the 1980s, however, an outbreak of rinderpest from Sudan spread throughout Africa, killing millions of cattle, as well as wildlife.^[22] In response, the Pan-African Rinderpest Campaign was initiated in 1987, using vaccination and surveillance to combat the disease.^[22] By the 1990s, nearly all of Africa, with the exception of parts of Sudan and Somalia, was declared free of rinderpest.^[22]

Worldwide, the Global Rinderpest Eradication Programme was initiated in 1994, supported by the Food and Agriculture Organization, the OIE, and the International Atomic Energy Agency.^[22] This program was successful in reducing rinderpest outbreaks to few and far between by the late 1990s.^[22] The program is estimated to have saved affected farmers 58 million net Euro.^[23]

The last confirmed case of rinderpest was reported in Kenya in 2001.^[24] Since then, while there have been no confirmed cases, the disease is believed to have been present in parts of Somalia past that date.^[24] The final vaccinations were administered in 2006, and the last surveillance operations took place in 2009, failing to find any evidence of the disease.^[24]

In 2008, scientists involved in rinderpest eradication efforts believed there was a good chance that rinderpest would join smallpox as officially "wiped off the face of the planet".^[4] The Food and Agriculture Organization, which had been co-ordinating the global eradication program for the disease, announced in November 2009 that it expected the disease to be eradicated within 18 months.^[25]

In October 2010, the FAO announced it was confident the disease has been eradicated.^[5] The agency said that "[a]s of mid 2010, FAO is confident that the rinderpest virus has been eliminated from Europe, Asia, Middle East, Arabian Peninsula, and Africa," which were the locations in which the virus had been last reported.^[5] Eradication was confirmed by the World Organization for Animal Health on 25 May 2011.^[6]

On 28 June 2011, FAO and its members countries officially recognized global freedom from the deadly cattle virus. On this day, the FAO Conference, the highest body of the UN agency, adopted a resolution declaring the eradication of rinderpest. The resolution also called on the world community to follow up by ensuring that samples of rinderpest viruses and vaccines be kept under safe laboratory conditions and that rigorous standards for disease surveillance and reporting be applied. "While we are celebrating one of the greatest successes for FAO and its partners, I wish to remind you that this extraordinary achievement would not have been possible without the joint efforts and strong commitments of governments, the main organizations in Africa, Asia and Europe, and without the continuous support of donors and international institutions", FAO Director-General Jacques Diouf commented.^[26]

The rinderpest eradication effort is estimated to have cost \$5 billion.^[27]

Stocks of the rinderpest virus are still maintained by highly specialized laboratories.^[24] In 2015, FAO launched a campaign calling for the destruction or sequestering of the remaining stocks of rinderpest virus in laboratories in 24 different countries, citing risks of inadvertent or malicious release.^[28]

Use as a biological weapon

Rinderpest was one of more than a dozen agents the United States researched as potential biological weapons before terminating its biological weapons program.^[29] Rinderpest is of concern as a biological weapon for the following reasons:

- The disease has high rates of morbidity and mortality
- The disease is highly communicable and spreads rapidly once introduced into nonimmune herds.
- Cattle herds are no longer immunized against RPV and therefore are susceptible to infection.^[30]

Rinderpest was also considered as a biological weapon in the United Kingdom's program during World War II.^[31]

See also

- Ovine rinderpest
- Rift Valley fever
- Murrain

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External links

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