Myxomatosis: population dynamics of rabbits (Oryctolagus cuniculus Linnaeus, 1758) and ecological effects in the United Kingdom

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Summary: In 1953-1955, myxomatosis spread among rabbits (Oryctolagus cuniculus) in the United Kingdom, causing 99% mortality. Subsequently, there was a gradual increase in rabbit numbers. By 1955, the Ministry of Agriculture, Fisheries and Food (MAFF) had already found attenuated strains of myxoma virus. By 1970, genetic resistance had appeared. In the 1970s, mortality declined to 47-69% with only approximately 25% of rabbits infected, giving a field mortality of 12-19%. However, myxomatosis is persistent, generally showing a major prevalence peak in autumn and often a minor peak in spring. An eight-year MAFF experiment in which prevalence of the disease was artificially reduced indicates that myxomatosis remains a significant factor in population regulation. After rabbit numbers fell in the 1950s, important ecological changes took place: vegetation altered due to reduced grazing pressure, predators were affected by the reduction of a major prey species and these changes also affected many other animals. Currently, rabbit numbers have returned to approximately one-third of pre-myxomatosis levels and this is causing damage to farm and conservation habitats.


INTRODUCTION

Myxomatosis was first confirmed in British rabbits (Oryctolagus cuniculus Linnaeus, 1758) in Kent in October 1953; by the end of 1954, the disease had spread through much of southern England and cases were being reported from most counties in the United Kingdom (2). All mainland rabbit populations had been affected by 1956 (16). The main vector is the rabbit flea (Spilopsyllus cuniculi) (8), although mosquitoes and other biting insects may spread the virus (10). Previously, the rabbit population in Britain was estimated at 60-100 million, but the initial epidemic of myxomatosis reduced numbers by 99% (7, 16).

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EPIDEMIOLOGY OF MYXOMATOSIS AND RABBIT POPULATION DYNAMICS

Within two years of the introduction of myxomatosis, attenuated strains of virus were found (5). Moderately virulent strains (killing 70-95% of susceptible rabbits) were transmitted more effectively and by 1962 these had virtually replaced the original, fully virulent strain (4). Genetic resistance to the disease was detected in wild rabbit populations in widely separated areas of Britain from around 1970 (9). As a result of these developments, mortality from myxomatosis is now much reduced in comparison with earlier outbreaks. During the 1970s, the Ministry of Agriculture, Fisheries and Food (MAFF) found that only 25-27% of rabbits were infected and that 47-69% of infected rabbits died, giving a field mortality rate of 12-19% (11).

Myxomatosis may persist in rabbit populations for long periods and, except in very low density populations, it is usually present throughout the year (10). The seasonal cycle shows a main peak in summer/autumn and a minor peak in spring (10, 11). Once myxomatosis is present, its prevalence in the population depends on the presence of sufficient numbers of vectors and a sufficient density of susceptible rabbits (10). Epidemics are most likely to start when fleas move between hosts more actively at the start and end of the rabbit breeding season (January/February and July/August), and in the autumn when there is high mortality from other causes such as predation, other diseases, etc. (10). The autumn epidemics reduce over-winter numbers and hence the size of the breeding population, and the spring epidemic is thought to attenuate summer population peaks while substantially reducing numbers of susceptible juveniles (10).

MYXOMATOSIS AND THE REGULATION OF RABBIT NUMBERS

In the 1950s, myxomatosis reduced rabbit numbers to a very low level, but as mortality from myxomatosis has declined numbers have gradually increased. However, an eight-year experiment by MAFF indicates that myxomatosis regulates winter numbers and influences the size of the adult population present at the start of the next breeding season (18). By removing the flea vector, the prevalence rate was significantly reduced. Within two years, the number of rabbits surviving the winter had increased two- to three-fold.

ECOLOGICAL EFFECTS OF MYXOMATOSIS

The myxomatosis epidemic in the 1950s had wide-ranging effects on the flora and fauna of the United Kingdom, and important ecological changes ensued (13). Grassland turf height increased as grazing pressure declined and grasses, small legumes and small annuals were encouraged to flower. Short grass ecosystems started to disappear in many places. Some smaller species, particularly annuals, were subsequently unable to compete with the rank vegetation and became rare. The seedlings of woody plants survived well, leading to the regeneration of scrub and woodland.
Brown hare (*Lepus europaeus*) numbers were high in the 1960s, perhaps because the lack of rabbit grazing and increased cover allowed better leveret survival, although numbers have since declined (1). Invertebrate numbers in chalk grassland increase at least three-fold when grazing is prevented (13) and this seems likely to have happened when rabbits declined in the 1950s. However, some specialist short-grass inhabitants became less common and the large blue butterfly (*Maculinea arion*) became extinct (13).

Many predators lost an important prey species and the stoat (*Mustela erminea*) population fell dramatically (13). Initially, fox (*Vulpes vulpes*) reproduction and numbers benefitted from rabbit carrion but numbers later declined until the early 1960s. In contrast, although weasel (*Mustela nivalis*) populations declined in places, they generally rose in 1957-1958 following the 1957 increase in small rodents in the luxuriant vegetation (6). Weasel numbers were then periodically high until at least the early 1970s (14) and the pre-myxomatosis ratio of stoats to weasels trapped or shot (1.9-2.6:1) was reversed (6, 13) although the present situation is less extreme.

Predatory birds were also directly or indirectly affected by the decline in the rabbit population (13). The buzzard (*Buteo buteo*) depended heavily on rabbit prey and most pairs failed to breed in 1955. This, together with greater persecution, reduced buzzard numbers by approximately 50% and much of the previous spread in distribution was reversed. Recovery is now complete and buzzard distribution has expanded, particularly in Northern Ireland (15). The tawny owl (*Strix aluco*) had poor breeding success in 1955, probably because the small mammal prey on which it feeds had been reduced by increased mammalian predation; however, later years showed a return to normal breeding patterns (12). Peregrine falcons (*Falco peregrinus*) have disappeared from the South Downs since the introduction of myxomatosis, following the loss of their short-grassland hunting habitat (13).

**PRESENT SITUATION AND THE FUTURE**

Over the past four decades, rabbit numbers have slowly recovered and by the 1980s they reached 20% of pre-myxomatosis levels (2). Recently, numbers have increased sharply; they are highest in the east and south-east, the south-west is intermediate and the north relatively low (17). Current estimates put overall numbers at one-third of pre-myxomatosis levels and rabbits are causing damage to both farm and conservation habitats (2, 3). Rabbit numbers are likely to increase further if the present trends continue (10, 11, 17).

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**Résumé :** En 1953-1955, la myxomatose s’est répandue parmi les lapins (*Oryctolagus cuniculus*) au Royaume-Uni, entraînant un taux de mortalité de 99 %. Les populations ont ensuite progressivement augmenté. Dès 1955, le
Ministère de l'agriculture, de la pêche et de l'alimentation (MAFF) avait observé l'apparition de souches atténuées du virus de la myxomatose. En 1970, des résistances génétiques étaient apparues. Dans les années 1970, le taux de mortalité est tombé à 47-69 % et seuls 25 % environ des animaux étaient infectés, ce qui aboutit à une mortalité effective de 12-19 %. La myxomatose persiste cependant, avec un taux maximal de prévalence en automne et souvent un pic secondaire au printemps. Au terme d'une expérience du MAFF qui a duré huit ans et qui consistait à réduire artificiellement la prévalence, il apparaît que la myxomatose reste un facteur important de régulation des populations. La réduction des populations de lapins dans les années 1950 a entraîné des changements écologiques importants : modification de la végétation, moins exposée à leurs attaques, conditions difficiles pour les prédateurs par suite de la raréfaction de leurs proies principales, et impact sur de nombreux autres animaux. Bien qu'à l'heure actuelle, les populations de lapins représentent environ un tiers de ce qu'elles étaient avant l'apparition de la myxomatose, elles provoquent toujours des ravages dans les cultures et les réserves naturelles.


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Resumen: Entre 1953 y 1955 se difundió la mixomatosis entre los conejos (Oryctolagus cuniculus) en el Reino Unido, con 99% de mortalidad. Después, las poblaciones aumentaron progresivamente. En 1955, el Ministerio de Agricultura, Pesca y Alimentación (MAFF) había ya observado la aparición de cepas atenuadas del virus de la mixomatosis. En 1970, resistencias genéticas habían aparecido. En la década de 1970, la tasa de mortalidad se redujo a 47-69% y solo alrededor de 25% de los animales estaban infectados, lo que significa una mortalidad efectiva de 12-19%. Sin embargo, la mixomatosis subsiste, con una tasa máxima de prevalencia en otoño y a menudo un pico secundario en primavera. Tras una experiencia de reducción artificial de la prevalencia efectuada durante ocho años por el MAFF, se observa que la mixomatosis sigue siendo un factor importante de regulación de las poblaciones. La reducción de la población de conejos en los años 1950 produjo importantes cambios ecológicos: modificación de la vegetación menos expuesta a sus ataques, consecuencias en los predadores por la disminución en número de sus presas principales e impacto en muchos otros animales. En la actualidad, las poblaciones de conejos no alcanzan sino a un tercio de sus efectivos antes de la aparición de la mixomatosis, pero siguen provocando estragos en los cultivos y en las reservas naturales.

REFERENCES


