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# **WILDLIFE AS VECTORS IN DISEASES: APPROACHES TO SOLVING THESE PROBLEMS IN THE UNITED KINGDOM**

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**ABSTRACT:** Interest in wildlife diseases and their importance to man and his livestock has increased in the United Kingdom during the past decade. Reasons for this are given and particular reference made to the single occurrence of rabies outside quarantine in Britain, in 1969 (the first since 1922), and to the links between bovine tuberculosis in badgers and in cattle.

Interest in ecology is now so world-wide, that the assaults upon the natural environment by pesticides, oil-spillage, human over-population and consequent pollution are familiar to all. There is a continuing need for the protection of some species and for the management of wildlife, as competitors with the farmer for his crops and stock, as a crop and an amenity in their own right and -- in the particular context of this paper -- as warm blooded vertebrates carrying diseases which may affect man or his domestic stock.

The British attitude to animals has long been equivocal and sectional, accused at one extreme of maudlin sentimentality and at the other of slaughter and cruelty. The near idolatry of the dog and cat by a considerable fraction of our population is almost proverbial, the pet food industry is substantial and draws its wares from as far afield as the Australian kangaroo, while many a legacy is devoted to the welfare of animals -- domestic or wild. The present century, and particularly the last three decades, has seen an increasing and intelligent appreciation of the unity and inter-dependence of life on our planet and a quickening of interest in its protection and conservation. This has been reflected in our legislation for the protection of both mammals and birds [Protection of Animals Acts 1911, 1927; Protection of Animals (Scotland) Acts 1912, 1921; Protection of Birds Acts 1954, 1967; Deer (Scotland) Act 1959; Deer Act 1963; The Deer (Close Seasons) (Scotland) Order 1966; Conservation of Seals Act 1970; Badgers Act 1973; Conservation of Wild Creatures and Wild Plants Act 1975; Endangered Species (Import and Export) Act 1976] and while these protection Acts contain sections permitting necessary control, a pest control Act (Pests Act 1954) includes provisions for banning both a cruel trap and using a disease (myxomatosis) for control purposes.

Conservationists have come to appreciate that over 4/5ths (49 million acres) of Britain is owned and occupied by landowners and farmers (Barber, 1970), and that agricultural and forestry practices exert a major influence on the ecology of the countryside. For management of wildlife, the greatest variety of natural and semi-natural habitats is desirable, but such interspersion has to be paid for at the rate of about £1 per acre a year, and at present the only likely means of recouping this is by rent from shooting. Pheasants and partridges are now regarded by many farmers as a supplementary crop and responsible shooting men are expressing, internationally, a more disciplined concern for the welfare of the stocks of their prey and wildlife generally. The practice of removing a croppable surplus, as by restricted shooting seasons and "bag limits" for game in the USA, is now more widely accepted (van Maasdijk, 1970). It was estimated in a sporting paper that "In Britain there are between 10 and 15 million acres of land from which shooting rents of between 50p and £2.50 per acre per year can be expected; there are 10 million acres suitable for grouse shooting; 4,000 shotguns are bought each year and 70 million cartridges are used; annual turnover among game farmers is about £500,000; 600,000 own shotguns; about 55,000 of them buy game licenses at £6 each year" (The Field, 15 April 1971).

Wildlife is a natural resource and its planned management, or conservation, includes cropping it where necessary. Deer damage trees, and sometimes arable crops, and were long regarded by foresters mainly as a pest. But it is not economically possible to exterminate deer and they are gradually coming to be treated in Britain, as elsewhere in the world, more as a croppable resource and an amenity.

At the first international conference on wildlife disease, in 1962, I discussed predatory vertebrates and concluded that although, in combination with parasites and diseases, they can sometimes effectively limit the population densities of their prey, they did not usually do so (Thompson, 1963). In most cases, and there are admittedly exceptions, predation entails the removal of animals which are supplementary to the carrying capacity of the habitat. Man is only partly an exception to this generalization about predators and subsequent work on mammals and birds, sufficiently successful and numerous to damage agriculture and forestry, has confirmed the view that the resources of men and materials are seldom available for general population control to be effected. Concentration of effort on specific crop protection, or local control, is much more rewarding. Scaip hunters and bounty systems die hard, but scaring techniques based on a knowledge of animal behaviour are usually more useful; although there is a place for controlled culling and sometimes outright killing.

When speaking of the ecology of diseases in wild mammals and birds at a British Veterinary Association meeting some years ago (Thompson, 1961), and the need for joint investigations of these diseases by ecologists and pathologists, I found it convenient to give examples of zoonoses -- plague, rabies and tularemia -- from the USA; mainly because of the amount of research which had been carried out. The principal reason for this was clearly expressed by H.N. Johnson in his keynote address to a Wildlife Disease Association annual conference (Johnson, 1970) when he referred to abrupt changes in the environment, such as deforestation, reforestation, plowing, irrigation, and the building of urban communities in previously rural or natural areas, as a prerequisite for zoonoses. He contrasted the American situation with the more stable and settled agricultural position in much of Europe, which has less wildlife disease.

A recent exception is rabies in foxes and to a lesser extent badgers, roe deer, and martens, in continental Europe. Apart from the deer in Richmond Park in 1886, there are few records of rabies in wildlife in Britain (Lloyd, 1976), where the disease has been an urban problem, controllable by strict quarantine and the destruction of infected domestic animals, mainly dogs. On 14 October, 1969 a dog with rabies was at liberty on a common in the Camberley area of Surrey for some 50 minutes, after it had bitten the owner. This may seem small beer in the context of rabies in USA, South America, and mainland Europe, but this was the first animal in Britain with rabies, outside quarantine or other confined premises since 1922. It killed a cat and could have bitten other domestic or wild animals while at liberty. Consequently, an exercise was mounted, using Army beaters and Ministry of Agriculture, Fisheries and Food shooting men and cyanide gassing of earths, to control the wildlife, mainly foxes, badgers, rats and grey squirrels, in the immediate area of the rabies incident. There was no incidence of rabies in wildlife and the exercise was valuable, but emphasized the great difficulty of controlling a potential epizootic and the need for much more information on the behaviour, home-range and movements of foxes in both urban and rural areas.

We are fully convinced of the need for more knowledge of the biology of particular wildlife species not only in relation to rabies but to agrochemicals and other problems, and are currently studying the behaviour, reproduction, parasites, aging, feeding habits and interactions with other species of a variety of animals. After the Camberley incident a Committee of Inquiry on Rabies (GB 1971) recommended stringent control of foxes where rabies is confirmed in wild animals, in a primary zone of 12 miles radius (452 sq miles), with gassing of earths and possibly other measures in a secondary zone of an additional 12 miles (another 1357 sq miles).

The Waterhouse (Rabies) Committee also recommended comprehensive legislation governing the importation of all mammals, under a single licensing authority. Since all mammals are believed to be susceptible to rabies, they considered it preferable to make general regulations and to list periodically the permitted exceptions -- such as Cetacea, Monotremata and Sirenia. Under these recommendations, implemented by the Rabies Act 1974, the Rabies (Importation of Dogs, Cats and Other Mammals) Order 1974, and the Rabies (Control) Order 1974, species belonging to most orders of mammals have a full six months quarantine, vampire bats may be imported only for approved purposes and are quarantined for life, but special licensing arrangements apply to ungulates. These regulations impose quarantine for the first time on many small mammals imported as pets, such as hamsters, chipmunks, ground squirrels, guinea pigs, and rabbits, and the conditions of quarantine are more stringent than previously applied. As one who deplors the breaking down of Wallace's faunal realms, I can but commend any regulations which restrict the importation of exotic mammals.

There is a limit to the extent to which wildlife can be managed by legislation, but it can be a powerful weapon for both the conservationist and the epidemiologist. The British Government's policy on rabies has two aims: (i) The Primary Aim: to keep rabies out of Great Britain by means of stringent import controls, compulsory quarantine requirements, severe penalties for offenders and the active awareness and support of the public; and, (ii) the Contingency Aim: should an outbreak nevertheless occur, to contain it and to stamp it out swiftly and effectively, to prevent the disease becoming enzootic. (Brown, 1977).

Another disease, of cattle, and man, which has quite recently been found to have a wildlife component, in parts of England, is bovine tuberculosis. The public health risk of raw milk from tuberculous cows was assessed in Britain in 1907 but it was not until 1930 that a plan for the eradication of bovine TB was produced. It was estimated, in 1934, that 40% of dairy cows were infected and concluded that total eradication of the disease was the only solution to the problem. An Attested Herd scheme was introduced in 1935 and by 1960 the whole of Britain was an attested area (Henderson, 1976). By this time the incidence of bovine TB in cattle was very low and, generally, it continued to decline but persisted in some areas of southwest England. There was no indication of a possible source of infection until a dead badger, found in April 1971 on a farm where tuberculin reactors with lesions had recently been detected, proved to have TB lesions in its lungs and *Mycobacterium bovis* was isolated from the carcase (Muirhead, Gallagher and Burn, 1974; Gallagher, Muirhead and Burn, 1976).

Of all British mammals, the badger (*Meles meles*) is perhaps the one held in highest regard by naturalists and the public generally. It is widely distributed in Britain and commonest in the southern and south-western counties of England and Wales. Largely nocturnal, truly omnivorous but very partial to earthworms, it has only occasionally been guilty of poultry killing and of rolling in corn and eating grain. It has never been listed as a pest of agriculture. Indeed, such is its popularity that it was given protection by the Badgers Act 1973, which makes it an offence to ill-treat any badger. It is thus particularly regrettable that some badgers have been found to be infected with bovine tuberculosis.

Cases of tuberculosis breakdown were usually only in young cattle, grazed separately, while the remainder of the herd passed the tuberculin test satisfactorily. The presence of badgers in the areas where young stock were grazing directed attention to a possible wildlife reservoir of infection and a variety of wild mammals, including badgers and samples of badger feces were collected for testing. During the last seven years, the existence of tuberculosis in badgers has been confirmed in other parts of Gloucestershire and in various areas of Cornwall, Wiltshire, Dorset and Devon. Tubercle bacilli from badgers have proved highly pathogenic and spread experimentally between badgers and from badgers to calves (Little, Burn and Stuart, 1975; Thompson and Rees, 1976).

The only practicable means of dealing with the problem was to follow a somewhat similar policy for badgers as is practised for cattle; that is to kill those affected and those exposed to infection.

The first area in which operations were undertaken to eliminate infected badgers was in South Dorset where for some years a high reactor rate had persisted in a dairy herd and a high level of infection existed in badgers. In 6 years since 1970, 626 cattle were slaughtered because they reacted to the tuberculin test or had been exposed to infection. Various techniques of dealing with the problem were tried out in this area.

Live traps were designed that were both efficient and humane. But the technique proved to be cumbersome and time consuming; over a period of 9 1/2 months from September 1974, when up to 42 traps were used, only 33 badgers were caught. It was concluded that the only satisfactory method of eliminating tuberculous badger colonies was to gas them in their sets, basing the method to be used on the technique already available for gassing rabbits in their warrens.

Although there were no legal restrictions on the use of gassing to control rabbits the use of this method to kill badgers in their sets was prohibited by the Protection of Animals Acts of 1911 and 1912. However, the Badgers Act 1973 (which is a badger-protection measure) authorises the Agriculture Ministers to issue licences for the killing of badgers to prevent the spread of disease, and this power was extended by including in the Conservation of Wild Creatures and Wild Plants Act 1975 a provision which, in effect, permitted the use of gas to be specified in such a licence. During the passage of this latter Act in Parliament an undertaking was given that licences for gassing would be issued only to Ministry staff or to persons under Ministry control.

Gassing operations began on 26 August 1975 and a year later the central area of 3,000 acres was cleared of badgers, after gassing of 260 sets and regassing of 304 sets. This position will be maintained for at least two years. To date, about 6 cwt of gassing powder has been used in 1898 holes. Some 10,000 acres have been under surveillance. There are relatively few badgers in the 7,000 acres beyond the area where the gassing has been carried out and any attempts to recolonize the gassed area are being discouraged. The total of badgers gassed is unknown. Tuberculin tests on the cattle have shown encouraging results -- over 500 were tested in Autumn 1976 and all passed the test. A test in August 1977 was completely clear, and a test in January 1978 was clear.

Another experimental badger clearance programme, agreed in outline with the Nature Conservancy Council was commenced near the town of Thornbury, Avon in December 1975. The area involved is bounded on the northwest by the River Severn, southwest by the M4, southeast by the M5 and northeast by the Little Avon river. Within this area lesions of tuberculosis had been disclosed from reactors in 39 cattle herds during the past 10 years and clear evidence of infection in badgers has also been obtained. The purpose of the experiment is to find out whether operations on this scale will eradicate bovine tuberculosis in the area.

A survey of the area in the summer of 1975 revealed some 440 sets of which about 200 appeared to be occupied. One set was gassed 19 times, in spite of all efforts with repellents, before re-opening ceased. It was intended to gas only the southern part of this large 40 square mile area but because of herd breakdown the whole area has now been treated. In all 219 sets have been gassed and 425 regassed. Repellents have been used extensively but have given very disappointing results.

The area has been continuously surveyed. Most of the sets are derelict and many overgrown. Badger activity over the whole area is now very slight and little regassing is necessary. The object is now to keep this relatively large area badger free for 2 years and to monitor cattle herds to check whether badger clearance results in freedom from tuberculosis.

The opportunity was taken to excavate several badger sets. There are few published accounts of the structure of badger sets and none of a set that has been accurately surveyed (MAFF, ADAS Report 1977).

Concurrently, a study of badger ecology and behaviour is being carried out in a valley in southwest England. The techniques described by Kruuk (1978) are being used and this work will be fully reported in due course. Its objective is to provide information on badger ranges and movements and to elucidate the role of badgers as vectors of tuberculosis.

In addition, chemical trails of concentrations of hydrocyanic acid gas attained in badger sets are being made; pathological investigations are progressing on the cultivation of M. bovis and the persistence of infection in badger sets. Other species of wild mammals are being examined for M. bovis (with negative results) and badger carcasses sent in by the public from all parts of the country are being examined (PICL Report, 1975; MAFF Report, 1976; MAFF Report, 1977; PICL Report, 1978).

Meanwhile in these areas of southwest England where there is evidence that sets are used by infected badgers and there has been tuberculosis in cattle in the vicinity, the policy of clearing sets by the use of cyanide gassing powder has been followed. There are indications that these measures are reducing the incidence of bovine tuberculosis among cattle in the southwest.

Although the operations being undertaken by the Ministry necessarily involve the elimination of badgers in districts where they have become infected with bovine tuberculosis, this action should not be of detriment to the future of the animal in those areas. After a suitable period of time has elapsed following eradication of the disease, reoccupation by healthy badgers will be permitted. The operations should thus prove of benefit to the long-term future of the species.

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