Caseous lymphadenitis first came to official prominence in Great Britain during the 1920's, when imported mutton from some countries was found to be badly affected by the disease. The Veterinary Officer to the City of London observed at the time that evidence of infection would often pass import meat inspection "only to be revealed when the roast leg of mutton appears on the table and is cut through". Imports from Argentina were particularly badly affected, forcing the British Government of the time to take action in relation to consignments of sheep from that country. The extent of the problem was demonstrated by a contemporary report that in a single season, 9,770 mutton carcasses (representing 27% of the total throughput) were rejected because of CLA, during one season at a Patagonian meat plant. Other mutton exporting countries took heed of the concerns in Britain and it was soon noted that "Argentina, Uruguay, Chile, Australia and New Zealand are actively occupied….in a struggle against this tenacious chronic disease which, completely neglected up to now, is very extensively affecting the flocks of those countries". Today, CLA is present in all of the major sheep and goat-rearing areas of the world, where its prevalence if often very high. With such a
wide distribution it is perhaps surprising that the farming industry of the United Kingdom remained free from the infection until relatively recently.

Caseous lymphadenitis in sheep and goats is caused by a bacterium known as *Corynebacterium pseudotuberculosis*. In some parts of the world (although not the UK) another strain of the organism also causes clinically significant infections in cattle and horses. Although very rare, human infections with the sheep/goat strain have been recorded amongst farm and abattoir workers. These zoonotic infections are associated with flu-like symptoms, fluctuating fever and chronic lymph gland enlargement, which responds poorly to antibiotic treatment and usually requires surgery to affect a cure.

It is generally accepted that *C. pseudotuberculosis* was first introduced to this country in 1987, entering with a consignment of 20 Boer goats that were imported from Germany to the north of England. The initial diagnosis of the disease was made in goats in 1990 and the first case affecting sheep was reported the following year. An interesting comparison was made recently between the *C. pseudotuberculosis* strain identified from the original 1990 outbreak and isolates from more recent cases in sheep. The results of this study confirmed that *C. pseudotuberculosis* organisms isolated in the UK virtually identical, consistent with all later CLA outbreaks in this country being directly related to that one original infection.

An examination of data from UK Veterinary Investigation Centres (see Figure 1 below) shows that the number of new CLA outbreaks in sheep flocks reached a peak in 2005 when more than 80 outbreaks were recorded. This followed a slight dip in diagnoses following the previous peak in 1998. Until recently the disease has been mostly associated with the terminal sire breeds, with a survey in 2001 suggesting that as many as 18% of such flocks might be affected to some degree. This led to concern that the spread of infection might be
accelerated by widespread distribution of these sires through the rest of the UK sheep industry. However, in the last few years the disease has also been diagnosed in traditional hill and upland breeds, suggesting that a further spread within the sheep industry may be occurring.

Experience of the condition around the UK suggests that the disease affects a disproportionate number of rams. Indeed, in most flock outbreaks dealt with by SAC Veterinary Service, the first animals to be identified as suffering from CLA have been rams. Rams are also the animals most frequently sold or loaned, making them the most common means by which the disease is transferred between otherwise closed flocks. In one closely studied Scottish case, CLA was shown to have been transferred between two flocks following the temporary loan of one ram for a short period during the breeding season.

A number of flocks producing high quality breeding rams have suffered serious financial losses due to CLA. Studies carried out in the Scottish Borders again
suggested that some pedigree flocks may suffering greatly from CLA, with infection rates as high as 50% seen amongst rams on some premises. It is thought that the management practice of running groups of males of different ages together, often at high stocking rates, may favour the spread of infection. As previously mentioned most CLA lesions tend to occur in the lymph nodes of the head and neck, which could encourage the spread of infection between animals during the feeding of concentrate rations to rams at a common trough. It would also tend to enhance the spread of infection via fighting wounds to the poll and face. However the exact routes of infection are still unclear and further work is required to assist in the understanding of CLA in the UK enabling the design of suitable control measures.

Recorded outbreaks of CLA in goats have been at a much lower level with the diagnostic rate remaining in single figures during much of the 1990's, before reaching a peak in 2002 when 14 outbreaks were identified. Despite the relatively small number of cases in goat herds, the infection can be particularly problematic in this species, with the more intensive conditions in most dairy goat enterprises being conducive to rapid disease spread.

In sheep and goats, entry of *C. pseudotuberculosis* to the animal host is usually gained via abrasions to the skin, at which point the bacteria are engulfed by the animal’s white cells. Rather than being destroyed by this process the organism's unusual outer structure allows it to survive within the cell, where it is carried via the lymphatic drainage to the regional lymph gland. Here the pathogen continues to multiply, before the host cell dies and releases many more of the bacteria. This recurring process of bacterial multiplication and cell death leads to the formation of the classic CLA lymph gland abscess. In some cases these abscesses act as a staging post for spread of infection to other sites within the body, most importantly the lungs and lymph glands within the chest, but occasionally also the liver, kidneys, brain or other organs.
An essential component in the bacterium's ability to establish itself and spread through the body is a toxin that it produces called phospholipase D (PLD). This toxin acts by damaging the host’s cells and strains of the bacterium that have had the gene for PLD deleted are unable to produce lymph gland abscesses. For this reason PLD is the principle component of CLA vaccines used around the world.

In UK sheep and goats, CLA infections most often cause abscessation of the superficial lymph glands of the head and neck, with the other lymph glands of the limbs and torso less commonly affected. These lesions are generally appreciated as firm and discrete swellings beneath the skin. The generally thinner coat of the domestic goat makes the visual identification of lesions much easier than in more heavily fleeced sheep. This tendency towards head and neck lesions is in contrast to the situation in other countries where CLA lesions in sheep are usually seem to affect the torso and are rarely seen on the head and neck.

The CLA abscess may or may not rupture and discharge spontaneously. If punctured, the contents are usually thick in consistency and olive green to cream in colour. The classic “onion-ring” appearance of chronic CLA lesions as described in veterinary textbooks is a relatively uncommon feature of the condition in this country.

An internal or “visceral” form of the disease is also recognised in the UK, with lesions most commonly seen in the lungs. On occasions these lesions may be so extensive as to seriously compromise lung function and may cause death. It is possible for a significant proportion of animals to have such internal lesions without showing external signs of disease. Around a quarter to a third of
infected sheep may have internal abscesses only at any given time. An example of the results of such internal infection is as follows.

Towards the end of 2005, the head shepherd of a large English flock was alarmed to discover the extremely poor condition of several rams within the estate's breeding stud. When the local veterinary practitioner visited to examine this group, a total of seven of the 55 terminal sire rams were identified as having a condition score of less than 2. There was no evidence of significant scouring within the group and the appetite of the affected sheep was reported to be normal. A decision was made to sacrifice the three worst affected rams and these were duly submitted to the local VI Centre for postmortem examination.

The results of the postmortem examinations carried out on these three Suffolk rams were very interesting. The first ram showed a marked thickening of the gut, which subsequent testing confirmed as a case of Johne's disease. However, when the other two rams were examined, neither showed any evidence of a similar intestinal condition. Instead both were found to have multiple abscesses throughout the lungs and within mediastinal lymph gland chain. These lesions ranged in diameter from that of a golf ball to a tennis ball. The contents of these thick-walled abscesses were firm and cheesy, and after two days of incubation in the laboratory cultures from the pus confirmed a pure and heavy growth of *C. pseudotuberculosis*. On further examination of these two carcasses, no other significant changes that might have explained the chronic weight loss could be seen. A diagnosis of systemic disease secondary to visceral caseous lymphadenitis (CLA) was duly made.

This case follows on from a number of similar reports of CLA associated with chronic systemic disease, which have come out from VI Centres in this country over the last three years. This is potentially significant development and
represents another reason for us to try and slow the spread of this disease in the sheep and goat industries.

Caseous lymphadenitis commonly enters a naïve sheep flock or goat herd through the introduction of infected animals. If left uncontrolled, disease prevalence may be expected to increase steadily over the course of a few years, the rate of spread tending to be greatest under more intensive conditions. Infection is disseminated within the flock or herd in one of two ways. Discharging abscesses release huge numbers of bacteria into the animal’s environment where it is theoretically capable of surviving for several months in the soil, on straw etc. In reality it seems that the vast majority of new infections are gained through exposure to other infected animals rather than to infection in the environment.

Possible routes of bacterial entry into the body include traumatic damage to the head e.g. due to fighting. Alternatively, injury to the ears from tagging or tattooing, or wounds to the lips and gums caused by orf lesions or during the shedding of juvenile teeth, may also provide an entry route for infection. Also possible is an oral route, when feed troughs or the food itself is contaminated by the bacterium.

Research from Australia indicates that the most important source of infection for sheep flocks in that country are animals with CLA abscesses in their lungs, which can generate an aerosol containing *C. pseudotuberculosis* organisms. This is most significant at shearing time, as these airborne bacteria can gain entry to the body via the minor skin damage caused during shearing. It is possible that a similar type of aerosol spread may also be important in disseminating infection within goat herds.
Superficial infections caused by other bacterium do occur sporadically in sheep and goats. On occasions these infections may spread locally to involve the drainage lymph nodes, when lesions are indistinguishable from those of CLA. Establishing an early diagnosis through bacteriology should therefore be the first priority with any skin condition in which abscesses are a feature. Similarly, non-infectious conditions may occasionally produce localised swellings around the head and neck. These include thyroid or thymus enlargement, haematomas, tumours and on occasion cysts.

If no action is taken to control an outbreak of CLA in a sheep flock then the expectation would be of a steady rise in prevalence within the group over a number of years. Experience from other countries suggests that more than half of the adult animals may eventually show clinical signs if no control measures are taken. *Corynebacterium pseudotuberculosis* is sensitive to a range of antibiotics in the laboratory. However, the nature of the organism with its ability to live intracellularly, surrounded by thick-walled abscesses, means that antibiotic therapy is unreliable.

Although proprietary vaccines are widely used around the world, no product is currently licensed for use in this country. The production of autogenous CLA vaccines in the UK is possible under an Emergency Licence issued by the Veterinary Medicines Directorate. Whether or not autogenous vaccination is considered, any control policy must incorporate regular examination of the herd and the removal of suspects. Ideally this should take place at least every three months, and once again the examination should concentrate on the lymph nodes of the head and neck. In a herd with a bacteriologically confirmed CLA problem, the detection of a lesion at the site of a lymph node can be considered diagnostic. It may then be possible to establish independent "clean" and "dirty" herds if space and accommodation allows. On most farms however, culling CLA positive animals is the usual course of action.
Experience suggests that if a programme of regular inspection and separation is pursued, the incidence of disease within the herd may be held in check. However the presence of a proportion of infected animals with the internal form of CLA means that complete eradication can never be achieved by this method.

The possibility of using blood testing to control the spread of CLA is now being promoted following the development of an ELISA test at the Moredun Research Institute in association with SAC Veterinary Service. This test, which detects antibody to the toxin produced by *C. pseudotuberculosis* during infections, is now available to the veterinary profession in the UK. The test has been successfully used to control infections in flocks where the disease is known to exist. This involves the repeated testing of all animals in the affected group at intervals of three or four months, with animals testing positive in the ELISA or showing clinical signs of disease being removed or culled. This method has effectively cleared infection from a number of flocks although it is not for everyone due to its relative expense the losses of otherwise healthy stock that can involved.

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