

## ***Clostridium botulinum* in soil on the site of the former Metropolitan (Caledonian) Cattle Market, London**

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### SUMMARY

Sixty soil samples were collected from the redeveloped site of the former Metropolitan (Caledonian) Cattle Market, Islington, London. Of these, 15 (25%) contained *Clostridium botulinum* and no less than four types (B, C, D and E) were demonstrated.

Early British soil surveys suggested that only 4–8% of samples contained *Cl. botulinum* (type A or B). Although there can be no absolute proof, it seems likely that the striking prevalence at the Market site was the result of faecal contamination by a small proportion of the many millions of farm animals brought there from elsewhere.

The distribution of *Clostridium tetani* was uneven, but of 18 soil samples taken from one area of the Market site, 16 (89%) were positive.

### INTRODUCTION

It has been known for many years that *Clostridium botulinum* may occasionally occur in the gut contents (Geiger, Dickson & Meyer, 1922) and internal organs (Gunderson, 1933; Dolman, 1964; Müller, 1967) of animals and birds. This is not surprising as the organism is a natural inhabitant of the soil. Easton & Meyer (1924) found it conceivable that animal excreta might aid in the country-wide distribution of spores, but concluded from their own evidence that any such effect must be slight. Research in the past 50 or more years has produced little information to warrant any change in this view.

Surveys carried out by Meyer & Dubovsky (1922), Leighton & Buxton (1928) and Haines (1942) suggested that *Cl. botulinum* (type A or B) occurred in 4–8% of British soil samples. Smith & Moryson (1975), Borland, Moryson & Smith (1977) and Smith, Milligan & Moryson (1978) discovered a much higher prevalence in mud from aquatic environments in various parts of Britain and Ireland. Smith & Moryson (1977*b*) found that in the London area lake mud was a much more favourable environment than soil for *Cl. botulinum*; of 25 soil samples only one could be shown to contain the organism (type B). Although not disclosed at the time, this single positive sample came from a small park on the site of the former Metropolitan (Caledonian) Cattle Market in Islington.

This report describes a detailed examination of the Caledonian Market site.

## MATERIALS AND METHODS

*Source of samples*

Sixty samples of soil were taken from park grassland on the redeveloped site of the Caledonian Market, Islington, London. Of these, one sample was collected in November 1975, five were collected in November 1976, and 54 in June 1978.

*Method of sampling and examination of samples*

The methods were closely similar to those used for soil samples by Smith & Moryson (1977*b*). Each sample consisted of material taken with a trowel from different depths of up to 12 cm below the turf, and from three different sites within an area of a few square metres. Trowels were washed and autoclaved before re-use. After storage at  $-20^{\circ}\text{C}$ , a 50 g portion of each sample was mixed with 100 ml of phosphate buffer and examined for *Cl. botulinum* by a method used earlier for lake mud samples (Smith & Moryson, 1975); this method was based on the examination of culture filtrates for the toxins of the various types of *Cl. botulinum* by neutralization tests in mice.

A number of filtrates produced easily recognizable tetanus in the mice. Eleven such filtrates were further examined by incubating each mouse dose with tetanus antitoxin (5 i.u.) at  $37^{\circ}\text{C}$  for 1 h before injection. This procedure invariably confirmed the reliability of diagnosing tetanus in mice on clinical grounds alone.

## RESULTS

The Caledonian Cattle Market was opened in 1855 by the Prince Consort and was finally closed in 1939; most of the area was occupied by stalls for some 7000 cattle, 35000 sheep, 1500 calves and 900 pigs (Hobhouse, 1971). The animals stood on a surface composed of granite sets (G. S. Wiggins, personal communication) – a surface that would have provided ample opportunity for seepage of faecal organisms into the soil beneath. Plate 1 indicates the original arrangement of the Market and the way in which the site was redeveloped between *c.* 1965 and 1971. Only the Clock Tower still stands, and the park grassland to the south of it, indicated in Plate 1 by the numbers 1, 2, 3, 4 and 5, constituted the source of the 60 samples.

Forty-two well-distributed samples came from the area indicated by the numbers 1, 2 and 3 (Plate 1) and formerly occupied by pigs, sheep and cattle. Of these samples 12 (28.6%) contained *Cl. botulinum*. Even more striking was the diversity of types demonstrated. Of the 12 positive samples six contained type B, two type C, two type D, one both types C and D, and one type E. Nine (21.4%) samples contained *Clostridium tetani*.

The source of the remaining 18 well-distributed samples was on the opposite side of a road (Market Road) at the site of the former bullock lairs, indicated in Plate 1 by the numbers 4 and 5. Of these, three (16.7%) contained *Cl. botulinum* (type B only), and no less than 16 (88.9%) contained *Cl. tetani*.

## DISCUSSION

There is little evidence to suggest that multiplication of *Cl. botulinum* occurs commonly in the alimentary tracts of animals, although Miyazaki & Sakaguchi (1978) have shown that types A, C and D are capable of multiplication in the caeca of chickens, and recent studies of human infant botulism strongly suggest intestinal multiplication of *Cl. botulinum* (Arnon *et al.* 1977). As already mentioned however, *Cl. botulinum*, presumably originating from the soil, is occasionally present in the gut contents of animals.

The prevalence of *Cl. botulinum* in mud from British lakes and waterways is high (Smith, 1978). One reason for this is thought to be the seeding of such environments that presumably occurs by means of the faeces of waterfowl that fly from place to place and by means of the occasional arrival, death and putrefaction of birds carrying *Cl. botulinum* in their intestines (Smith, 1976). Additional reasons are thought to be that mud sometimes (Smith & Moryson, 1977*b*) though not always (Smith & Moryson, 1977*a*) constitutes a particularly favourable environment for *Cl. botulinum*, and that the dispersal of proliferating organisms occurs easily in aquatic surroundings.

It also seems possible that movements of farm animals influence the distribution of *Cl. botulinum* in soil. However, unless such movements are on a very large scale the effects are, for the following reasons, likely to be less striking than those produced in mud by waterfowl. Whilst seeding of new environments with *Cl. botulinum* in the faeces of a small proportion of farm animals may seem inevitable, seeding as a result of death and putrefaction of carrier animals must be a comparatively rare event. Moreover, soil in certain areas constitutes a less favourable environment than mud for *Cl. botulinum* (Smith & Moryson, 1977*b*), and even if it were to support multiplication of the organism, dispersal would be less efficient than in aquatic surroundings.

Many millions of farm animals must have passed through the Caledonian Market during the 85 years of its existence. Although there can be no absolute proof, we consider that these animals were in all probability responsible for the high prevalence of *Cl. botulinum* spores and the diversity of types revealed by the present survey of soil on the Market site. The soil surveys carried out in the past in this country have indicated a low prevalence (4–8% of samples) of *Cl. botulinum* (types A and B), and for this reason we think it unlikely that top soil purchased and added during redevelopment of the Market site could have been responsible for the heavy contamination detected. The early British soil surveys (Meyer & Dubovsky, 1922; Leighton & Buxton, 1928; Haines, 1942) were carried out without the knowledge that excessive heating of samples and failure to trypsinize culture filtrates may sometimes interfere with the demonstration of certain types of *Cl. botulinum*. However, in the recent small-scale survey in London (Smith & Moryson, 1977*b*) only one of 25 soil samples was positive, despite the use of a sensitive method.

The prevalence of *Cl. tetani* in the soil of the Market site was also considerable, especially in the area indicated by the numbers 4 and 5 (Plate 1) where the organism

was demonstrated in 16 of 18 samples. The reasons for this were probably similar to those responsible for the high prevalence of *Cl. botulinum*. The area indicated by the numbers 1, 2 and 3 (Plate 1) differed significantly from that indicated by 4 and 5, in respect of *Cl. tetani* and possibly *Cl. botulinum*. No firm explanation can be offered, but it should be remembered that the soil must have undergone considerable disturbance during redevelopment of the site.

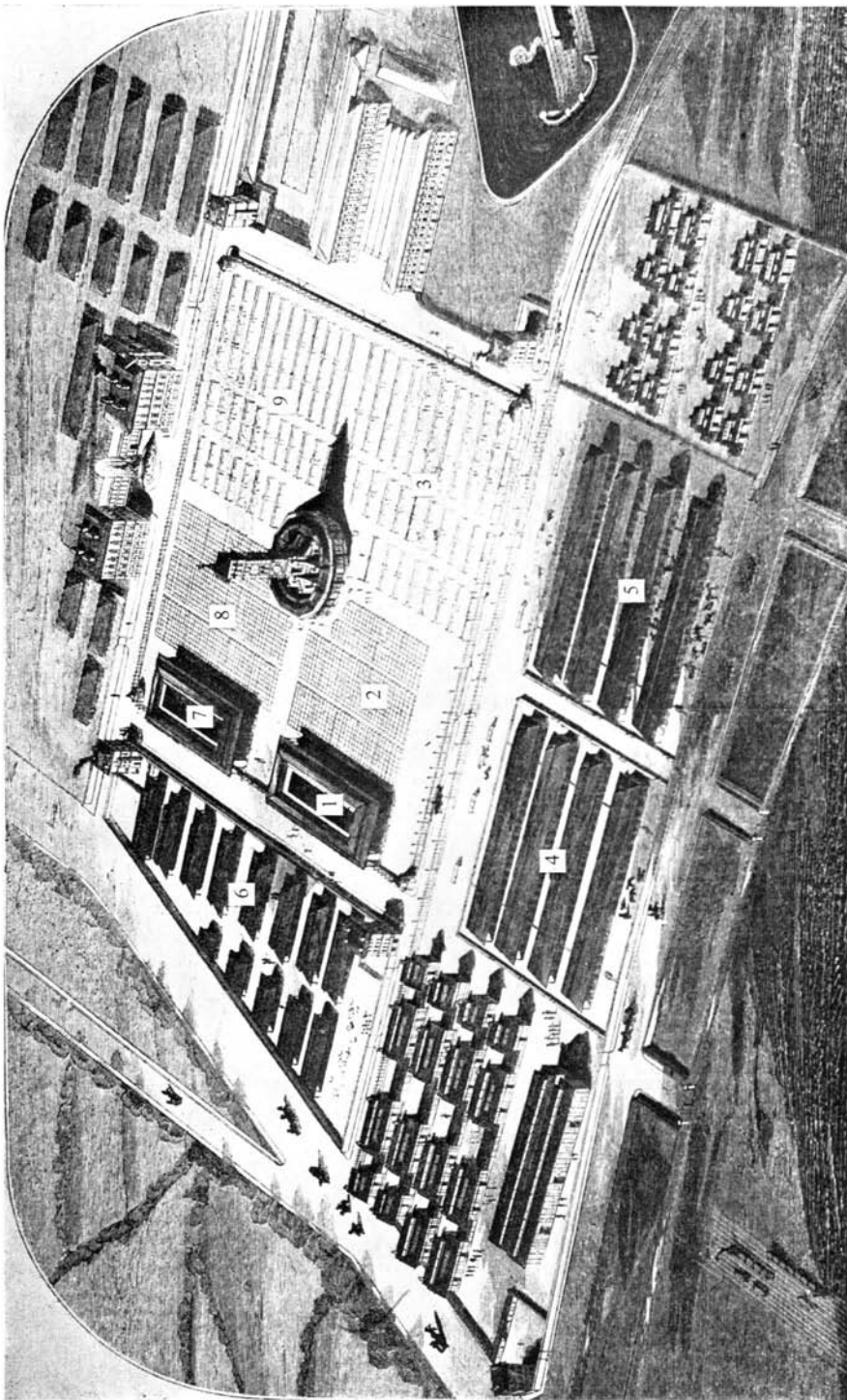
A reassessment of the distribution of *Cl. botulinum* in British soil by means of a sensitive method would seem timely. Any future soil survey should include samples from places where, over considerable periods of time, large numbers of animals have congregated.

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EXPLANATION OF PLATE

PLATE 1

The Metropolitan (Caledonian) Cattle Market, London, *c.* 1855. (Illustration by courtesy of Islington Libraries.) 1 = Pigs, 2 = sheep, 3 = cattle, 4 and 5 = bullock lairs, 6 = sheep lairs, 7 = calves, 8 = sheep, 9 = cattle. The soil samples were collected from locations 1, 2, 3, 4 and 5, all of which are now under grass as a result of redevelopment of the Market site. Locations 6, 7, 8 and 9 have now either been built upon or paved.