An epidemiological study of *Salmonella montevideo* by biotyping

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SUMMARY

Among 622 cultures of *Salmonella montevideo*, 27 biotypes belonging to two biogroups were recognized. One biogroup (10di) was predominant in all animals in Scotland but only in sheep in England and Wales. The other (biogroup 2d) was responsible for almost all human, cattle and poultry infection in England and Wales, but only 24 % of human infection in Scotland.

INTRODUCTION

Salmonella montevideo infection has been recognized as a cause of serious illness in sheep (Sharp *et al.* 1983). The epidemiology of the disease is as yet unclear, although sheep movements may be a contributory factor. Wild birds, particularly seagulls, appear to be involved in local spread (Linklater, 1983). It has also been suggested that seagulls may be an important reservoir of the organism (Coulson, Butterfield & Thomas, 1983). *S. montevideo* is also a significant cause of human salmonellosis in the United Kingdom, although considerably more so in England and Wales than in Scotland.

In an attempt to obtain further information on the epidemiology of this infection, a retrospective biotyping study was made using available cultures of *S. montevideo*.

MATERIALS AND METHODS

The biotyping of *S. montevideo* was performed at the Department of Medical Microbiology, University of Dundee Medical School. The system used was developed from a scheme originally devised for the biotyping of *S. typhimurium* (Duguid *et al.* 1975). Fuller details of the biotyping tests and results will be published elsewhere.

Table 1. *Biotypes* of 622 cultures of* S. montevideo

Biotype (and number of cultures of type)

2d and variants (125)
1a (4), 2d (116), 2dg (3), 2dj (1), 2dz (1)

10di and variants (497)
9di (3), 9i (1), 10bdi (30), 10bdi fuc⁻ (1), 10bdhi (1), 10cdi (1), 10di (305),⁻ 10di dul⁻ (3), 10di fuc⁻ (40), 10dgi (5), 10dij (2), 10dix (48), 10dhix (2), 10diyz (2), 10diz† (48), 12cdi dul⁻ (1), 12di (2), 14diz (2)

* For biotype designations see Duguid *et al.* (1975).

† The growth factor requirements among the 48 cultures of biotypes 10diz were: arginine (44); leucine (1); methionine (1); leucine and methionine (1); and unknown (1). In the total of 27 full biotypes, these count as five distinct biotypes.

dul⁻, dulcitol non-fermenting; fuc⁻, fucose non-fermenting.

A total of 622 cultures of *S. montevideo* relating to the period 1977–83 was examined, of which 490 were obtained from human, animal, bird, food, feed and other environmental sources in Scotland. These were obtained from isolates submitted to the Scottish Salmonella Reference Laboratory and represented virtually every human, veterinary and environmental incident reported to the Communicable Diseases (Scotland) Unit over the seven-year period. Cultures from England and Wales for 1982–3 were provided by the Central Veterinary Laboratory, Weybridge and by several area and regional laboratories of the Public Health Laboratory Service.

RESULTS

The 27 biotypes detected belonged to two biogroups (Table 1). The major biotypes were 2d (116 cultures) and 10di (305 cultures) which although closely related are nevertheless distinct. The biotyping characters of representative cultures of the two types were stable and reproducible on repeated testing and there was no observed interconversion *in vitro*. In addition to the two major biotypes, another 25 full biotypes were detected of which four (9 cultures) were considered to be variants derived from type 2d; 21 (192 cultures) were variants from type 10di. The six most common biotypes, namely 2d, 10di, 10bdi, 10di fuc⁻, 10dix and 10diz (arginine) accounted for 94 % of all cultures tested.

The two biogroups identified showed different but consistent distributions in the cultures examined from different sources (Table 2). The most striking finding was between isolates from animals in Scotland and from those in England and Wales. The 10di biogroup (biotype 10di and variants) was predominant in Scotland (98·6 %), whereas in England and Wales the 2d biogroup (biotype 2d and variants) was more common (63·4 %). In Scotland the two biogroups showed the same distribution among isolates from all animals. In England and Wales, however, the distribution of the biogroups in sheep differed to that in other animals but was similar to that in sheep in Scotland. Isolates from man in England and Wales almost invariably belonged to biogroup 2d, as did those from poultry and cattle, whereas in Scotland only 24 % of human isolates were of this biogroup, which was rarely found in animals and birds.

Table 2. *Biogroups of* S. montevideo *from animals, birds and man in Scotland and England and Wales*

	Biogroup	Sheep	Cattle	Poultry	Other birds	Other animals	Total all animals	Man
Scotland 1977–83	2d	0	1	1	0	1 (dog)	3 (1·4%)	27 (23·9%)
	10di	172	16	1	27	1 (mink)	217 (98·6%)	87 (76·1%)
England and Wales 1982–83	2d	2	25	32	0	0	59 (63·4%)	16 (94·1%)
	10di	30	2	1	0	1 (terrapin)	34 (36·6%)	1 (5·9%)

Table 3. *Biogroups of* S. montevideo *from environmental and other sources in Scotland and England and Wales*

	Biogroup	Abattoir drains	Sewage sludge/ effluent	Human food	Animal feeds	Streams	Other
Scotland	2d	1	8	0	0	0	1*
	10di	34	83	7	5	13	4†
England and Wales	2d	0	0	0	9	0	1‡
	10di	0	0	2	9	0	1‡

* Refuse tip water. † Water trough (2), reservoir (1), mud (1). ‡ Seawater.

A total of 178 isolates from environmental and other sources was also biotyped (Table 3). The distribution of the biogroups of the 156 Scottish isolates reflected that present in the corresponding human and animal populations.

DISCUSSION

The most obvious comparison to be made is between the distribution of biogroups of *S. montevideo* identified in Scotland and those in England and Wales. Even though relatively few cultures were examined from England and Wales the observed differences justify some comment.

Sheep. Although infection with *S. montevideo* in sheep has been a serious problem in Scotland, it has also occurred south of the border (see Figure 1). The results indicate that biogroup 10di was endemic in sheep and the possibility of a 'sheep' strain received support from the finding that in England and Wales sheep isolates were consistently of a different biogroup from that of most other isolates. Among the sheep isolates from England and Wales examined the distribution was wide, namely Bath (1), Bristol (1), Newcastle (19), Northampton (2), Worcester (8), Wye (1). The greater number of cultures from north-east England probably reflects geographical proximity to the main focus of infection in south-east Scotland. Sheep movements may account for the widespread involvement of other English regions.

If contamination of pasture by gulls represents a major feature of transmission as has been suggested (Coulson, Butterfield & Thomas, 1983), it might have been

Fig. 1. Distribution of incidents of *S. montevideo* in sheep, 1977–83, reported to M.A.F.F. under the Zoonoses Order, 1975.

expected that cattle in England and Wales would also have been infected with biogroup 10di (see below).

Although further subtypes of biogroup 10di were identified among sheep isolates, they did not show any correlation with either severity of disease or geographical distribution.

Poultry. The situation in poultry was the converse of that in sheep. Infection has largely been confined to England and Wales (Reports 1977–83) where all but one of the poultry isolates examined belonged to biogroup 2d. Only single Scottish poultry isolates were made in 1978 (biotype 10diz) and 1981 (biotype 2d). If, as seems likely, disease transmission is due to movement of infected birds, it is understandable that there has been little spread of infection to Scotland as legislation restricts the movement of poultry from England and Wales to Scotland, but not vice versa (Statutory Instruments, 1971).

Wild birds. Only Scottish isolates were available, the biotypes of which matched those found in the corresponding animal populations. This was not unexpected as most of the material was obtained during investigations into animal disease incidents. Since biogroup 2d accounts for 24 % of human isolates in Scotland and in view of the fact that many birds feed at sewage works and refuse tips, it was perhaps surprising not to have identified biogroup 2d. This finding however, further supports the theory that infection in wild birds merely reflects that of local animal populations. In England and Wales biogroup 2d accounts for 63 and 94 % of animal and human isolates respectively. It would therefore seem more likely that wild birds would become infected with this biogroup. Unfortunately no cultures were available to confirm this. It does appear that wild birds are unlikely to be responsible for the introduction of infection into Scotland from other parts of the United Kingdom.

Cattle. S. montevideo caused less serious disease in cattle than in sheep. Often only single animals were affected and it may be that cattle are not natural hosts for this organism. The biotypes found among bovine isolates again may reflect those present locally; thus biogroup 10di was predominant in Scotland. The only Scottish isolate of 2d was in 1981, the only year in which it was found in poultry, and on premises adjacent to a poultry farm. In England and Wales, however, the predominance in cattle of biogroup 2d mirrored the situations in poultry and man.

Man. The biotypes observed in man are dependent on the sources of infection. It was not surprising therefore to find in England and Wales, where *S. montevideo* is frequently isolated from poultry, that the poultry-associated biogroup 2d was the more prevalent. Although more Scottish isolates were available for examination *S. montevideo* is relatively infrequently isolated from man in Scotland compared with England and Wales. Nevertheless nearly 24 % of human isolates in Scotland were of biogroup 2d, probably associated in part with consumption of poultry meat originating in England and Wales, there being no restriction on movement of such poultry products into Scotland. In addition several persons were known to have contracted their infections abroad.

Biogroup 10di represented the majority of isolates from humans in Scotland, possibly as a result of the predominance of this group in sheep and cattle. In addition the seven isolates obtained from human food in Scotland, all poultry products, also belonged to this biogroup. Five of these originated from Ireland and the origin of the remaining two was not known. This would suggest that *S. montevideo* biogroup 10di is the poultry associated group in Ireland in contrast to biogroup 2d in England and Wales. The two food sample isolates examined from England and Wales were both 10di, but as these had been imported from Canada did not reflect the true picture of contamination in the food chain.

Animal feeds. In Scotland all the positive animal feeds were of biogroup 10di.

However all samples were obtained during investigation of disease episodes and there is the possibility of cross contamination having occurred on the farm.

In England and Wales many of the isolates were obtained during routine sampling of animal feed components. Biogroup 2d was recovered from products such as bonemeal or feathermeal, whereas fishmeals often yielded biogroup 10di. Animal feed was therefore a potential source of both biogroups.

Environment. The biogroups observed in environmental samples examined, almost all from Scotland, depended on the source. Abattoir drains and streams obviously reflected the biotypes present in animals. Sewage would however contain organisms primarily of human origin but on occasion also from animals where abattoir effluent was received. In consequence both biogroups were present. Although biogroup 2d was present in 10 % of the sewage samples examined, the fact that this biogroup was rare in animals in Scotland suggests that sewage sludge has a minimal role to play in the epidemiology of the disease.

Biotyping has clarified some of the epidemiology of *S. montevideo* infection. Although 'sheep' strains have been identified it has not yet been possible to correlate biotype with severity of disease. It may be that the development of other schemes, such as phage typing used, in conjunction with biotyping will lead to further understanding.

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