THE VARYING EPIDEMIOLOGY OF Q FEVER IN THE SOUTH-EAST REGION OF GREAT BRITAIN

II. IN TWO RURAL AREAS

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(With 1 Figure in the Text)

An investigation of Q fever in the Romney Marsh area of Kent was originally undertaken for several reasons: to determine whether its large sheep population was infected with *Rickettsia burneti*; to find flocks from which material could be obtained for the isolation of *R. burneti*; and to see if the epidemiology of Q fever among the human inhabitants of the area was consistent with the view that sheep were acting as a source of their infection.

A preliminary report has been made on the existence of Q fever in man and sheep in the Marsh (Marmion, Stewart, Richmond, Barber & Stoker, 1954), and also on the isolation of *R. burneti* from the local sheep (Stoker, Brown, Kett, Collings & Marmion, 1955*a*) and the Kentish sheep tick, *Haemaphysalis punctata* (Stoker & Marmion, 1955).

Apart from the large numbers of sheep in the Marsh, there are also cattle and a few goats. The possibility therefore remains that Q fever among Marsh residents might be related more to the presence of these animals, in particular to that of the cattle, than to that of the sheep. Consequently it was desirable to determine, as a control, the prevalence and epidemiological pattern of Q fever in another area where there were few sheep, but which was similar geographically, meteorologically and also in its numbers of cattle. For this reason the Chatteris and North Witchford rural districts (R.D.) in the Isle of Ely, Cambridgeshire, were studied and the results compared with those found in the Romney Marsh.

As the investigation progressed it became clear, however, that any influence of the sheep population on human Q fever in the Romney Marsh was partly obscured by the differing rates of infection of cattle, despite their equal numbers in the two areas. Nevertheless, the results of the investigation in the two areas are of interest, particularly when they are compared with those from the investigation in the two towns (Marmion & Harvey, 1956). Lastly, the paper is also intended to give an integrated account of our findings in the Romney Marsh.

GENERAL CONSIDERATIONS AND METHODS

The two areas

Both areas are agricultural in the wider sense, but Chatteris–Witchford R.D. is predominantly arable whereas the Romney Marsh is devoted mainly to sheep raising. They are approximately equal in size and human population. Both areas

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contain some reclaimed marshland and the topography is rather similar. The towns and villages are small and most of the inhabitants are occupied in agriculture or its ramifications.

The number of sheep in the Chatteris–Witchford R.D. is very small, only one flock of breeding ewes being present regularly; this is in contrast to the number of sheep in the Romney Marsh where there are some 75 ewes or 287 of all kinds of sheep per 100 acres of crops and grass. The numbers of cattle are similar in both areas, but more pigs and probably more goats are kept in the Chatteris–Witchford R.D. (Table 1).

Epidemiological method

The method of investigating patients in the two areas who had suffered from either pneumonia or undiagnosed fever during the period 1949–54 has already been described in detail in a previous paper (Marmion *et al.* 1954). Patients were drawn from all parts of the two areas and not restricted to the towns, but those attending antenatal or haematological clinics were not included. Patients were divided into those who had had Q fever and those who had not, and the epidemiological qualities of the two groups were compared.

A measure of the prevalence of Q-fever antibody in the general population of the Romney Marsh was obtained by sampling healthy adult volunteers rather than blood donors as described for the urban area investigation (Marmion & Harvey, 1956). In Chatteris–Witchford R.D. some blood donors were available but it was necessary to supplement them with adult volunteers.

RESULTS

In the earlier investigation in the Romney Marsh sixty-two patients (mostly adults) who had had pneumonia or unexplained fever were tested for the presence of complement-fixing (CF) antibody to *R. burneti* in their serum using the technique of Stoker, Page & Marmion (1955*b*). Subsequently an additional thirty-three patients, some of them children under 10 years old, were tested. There was thus a final total of ninety-five patients who had had either pneumonia or undiagnosed fever during the period 1949–54. In the control area—Chatteris–Witchford R.D.—fifty patients who had had pneumonia or unexplained fever were investigated. The age and sex distribution of the patients in the two areas was similar.

Clinical aspects of the cases

An examination of the clinical histories of the patients in the two rural areas revealed that the majority of patients were those who had suffered from pneumonia after a severe 'cold' or 'influenza' or as a complication of some pathological condition in the chest. Thirteen of the ninety-five patients in the Romney Marsh had CF antibody to *R. burneti* at a serum titre of 1/40 or more. As before, the choice of the level of 1/40 as significant rested on previous experience and a consideration of the differences in frequency distribution of antibody at various levels in, on the one hand, healthy adults in the area, and, on the other hand, the pneumonia or fever patients (see Table 2). One of the thirteen patients with CF

Table 1. *Summary of epidemiological information for the two areas*

Place	Population	Area (acres of crops and grass)	No. of animals per 100 acres of crops and grass: Cattle	Sheep (ewes only)	Pigs	Survey of pneumonia/fever patients: Serological and clinical classification: Q fever	Other	Total	Proportion of cases using raw milk at onset of illness: Q fever	Other	Proportion of healthy adults with CF antibody at titre of 1/10 or greater	Proportion of all dairy herds in area with infected herd milks
Chatteris–Witchford R.D. (Fens, Cambridgeshire)	10,662	34,570	12	1	25	0	50	50	0	14/50 (28)	2/107 (1·9)	0/16
Romney Marsh (Kent)	9,247	31,270	10	75	7	13	82	95	6/13 (46)	33/82 (40)	16/106 (15)	2/17

Figures in parentheses show percentage of total in subgroup.

Table 2. *Distribution of serum titre of complement-fixing antibody to* Rickettsia burneti *among persons who had had pneumonia or undiagnosed fever and also in healthy adults in the two areas*

	No. of persons with CF antibody at a serum titre of: <1/10	1/10	1/20	1/40	1/80	1/160 or greater	Total
Patients with pneumonia or fever:							
Romney Marsh	72	5	5	1	5	7	95
Chatteris–Witchford	48	1	1	0	0	0	50
Healthy adults:							
Romney Marsh	90	14	1	1	0	0	106
Chatteris–Witchford	105	1	1	0	0	0	107

The vertical dotted line divides the non-significant titres from those accepted as significant.

antibody above the chosen level, a schoolboy aged 8, had suffered from 'virus pneumonia' during a household outbreak of this disease. The other sick members of the family, examined at an optimal time after their illness, were serologically negative, so there is some doubt as to whether the boy's illness was due to *R. burneti*. The remaining twelve patients in the series had had illnesses which were clinically suggestive of Q fever and a fourfold or greater rise in CF antibody level was demonstrated during the course of illness in three of the patients. All thirteen patients will now be referred to as cases of Q fever without distinguishing between the schoolboy and the rest. This is in accordance with the procedure followed by Marmion & Harvey (1956) and is adopted for the same reasons of clarity and brevity.

In the Chatteris–Witchford R.D. none of the fifty patients who had had pneumonia or undiagnosed fever was found to have CF antibody to *R. burneti* at a serum titre of 1/40. Examination of 107 healthy adults in this area showed that only two (1·9%) had CF antibody at titres of 1/10 or more, in contrast to the 16/106 (15%) in the similar group in the Romney Marsh (Table 2) and 19/240 (8%) in the urban area.

Table 3. *Age and sex distribution of ninety-five patients who had suffered from pneumonia or fever, arranged according to their evidence of infection with* Rickettsia burneti

	Age in years at onset of illness					
	Males			Females		
	0–20	21–50	51 or more	0–20	21–50	51 or more
Q fever	1	8	3	0	1	0
Other pneumonia or fever	10	18	20	12	6	16
Total	11	26	23	12	7	16

EPIDEMIOLOGY

Age and sex of the patients

Table 3 shows the age and sex distribution of the ninety-five patients in the Romney Marsh who had had either pneumonia or undiagnosed fever arranged according to their reaction in the complement-fixation test. It will be noted that persons with CF antibody at, or above, a serum titre of 1/40 (Q fever) were commoner among males than among females—some 12/60 males being positive compared with 1/35 females. This finding contrasts with the higher incidence of Q fever among the females in the urban area (see table 2 of paper by Marmion & Harvey, 1956), but the difference may be due partly to a more thorough sampling of women in the age group 21–50 years in the latter area.

Effect of length of residence in the Romney Marsh on liability to infection

Table 4 shows the length of time that the patients with pneumonia or fever and also persons involved in a small outbreak of Q fever (see below) had been living in the Romney Marsh. It will be seen that both the sporadic Q fever infections and

those in the outbreak were commoner among those who had been in the area less than 11 years. Similar findings were obtained in the urban area.

Distribution of cases by month of onset of their illness

Fig. 1 shows the distribution of the ninety-five cases of pneumonia or fever in the Romney Marsh and the fifty cases in Chatteris–Witchford R.D. by their month of onset of illness. The open squares represent those patients who did not have CF antibody at a level of 1/40 or more and the blacked squares the cases of Q fever. It will be noted that in contrast to the findings in the urban area, the onset of illness of the cases of Q fever in the Romney Marsh were closely grouped in time, nine of the thirteen beginning their illness during the period from the second half of April to the first half of June. An outbreak of ten cases of Q fever (described

Table 4. *Relation between the length of time that the ninety-four patients with pneumonia or fever had been living in the Romney Marsh and their serological state. Similar information is given for thirty persons involved in an outbreak of Q fever*

	Sporadic cases* Length of residence			Play outbreak Length of residence	
	1–10	11 or more years		1–10	11 or more years
Q fever	12	1	Q fever	8	2
Other pneumonia and fever	38	43	Healthy actors	10	10
Total	50	44	Total	18	12

* Information was lacking on one patient in the series of ninety-five.

below) is represented by the figure 10 in a square and, it will be noted, also occurred at about this time. It is in these months that lambing and shearing take place in the Romney Marsh; lambing mainly during the first 2–3 weeks in April—a few lambs may be born as early as the beginning of March or as late as the end of June—and shearing most commonly in June. In connexion with the shearing it is of interest that there were two cases of Q fever among contacts of wool sorters working in a wool-storage warehouse in the neighbouring market town of Ashford. It will be seen from Fig. 1 that the onset of the illness in these patients was slightly later than that of the Q fever cases in the Marsh and at a time when the clipped wool was being received and sorted in the warehouse.

The time of lambing and shearing in the one flock of breeding ewes in Chatteris–Witchford R.D. is also given in the figure. Lambing took place under cover and there were no cases of Q fever associated with the flock, which, when sampled, contained no serologically positive sheep.

Cases of Q fever were found in each year of the survey period 1949–54 with the exception of 1950 (three cases in 1949; one in 1951; four in 1952; three in 1953; and two in 1954).

Geographical distribution of the patients

Twenty-one of the fifty patients in Chatteris–Witchford R.D. were living in Chatteris and the rest were dispersed either in small villages or in the country throughout the area. In the Romney Marsh fifty-one of the ninety-five patients were resident in one or other of the five towns or large villages (Appledore, Brookland, Littlestone, Lydd and New Romney), while the rest were scattered throughout the area in smaller villages or in isolated farms and cottages. The cases of Q fever were localized neither by place of residence, nor, in the main, by place of work, although two patients worked on the same farm.

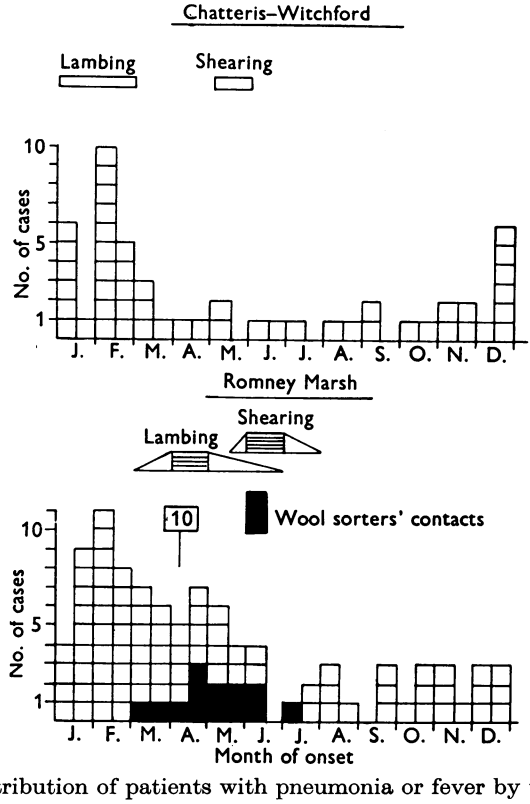

Fig. 1. Distribution of patients with pneumonia or fever by the month of onset of their illness and their serological state.

Occupational contact with potential sources of infection

In the series of fifty cases of pneumonia or fever in Chatteris–Witchford R.D. there were twenty-five (50 %) who were full-time agricultural workers. Nineteen of the fifty patients had occupational contact with cows, but only three had contact with sheep. The epidemiological experience of the 107 healthy adults sampled in this area was rather similar. Thirty-three (31 %) were agricultural workers; twenty-seven (25 %) had contact with cattle; five (5 %) with sheep; and thirty-four (32 %) with pigs. In spite of the high proportion of the total sample who had contact with cattle, there was, nevertheless, no clinical and little evidence of subclinical Q fever among them.

The thirteen cases of Q fever in the Romney Marsh had the following occupations: five agricultural workers, a printer, a hairdresser, a grocer, a toolroom fitter, the manager of a social club, a retired transport worker, a housewife and a schoolboy. The five agricultural workers all had contact with sheep. Three of these flocks of sheep (flocks 1, 3 and 5 of Marmion *et al.* 1954) were tested and found to have complement-fixing antibody to *R. burneti*. In addition, a strain of *R. burneti* was isolated subsequently from the placenta and wool of sheep in flock 3 (Stoker *et al.* 1955*a*).

Milk as a potential source of infection

Three of the five agricultural workers in the Romney Marsh had been using pasteurized milk in their homes at the time of illness and the other two had used raw milk. However, this raw milk was probably not the source of infection for these two cases. The bulked milks and the cattle belonging to the herd which supplied one of the two workers were tested and found to be free from infection. The other man was a workmate of one of those using pasteurized milk at home and, like the latter, was probably infected from the sheep on the farm where flock 1 was kept.

Four of the remaining eight patients with significant levels of Q-fever antibody, namely, the grocer, the retired transport manager, the housewife and the schoolboy, had used either tuberculin-tested or 'Channel Islands' milk from dairy A^1 which came from two local herds of cattle which were subsequently found to be infected with *R. burneti*. Pasteurization of this milk, which constituted about a tenth of all the milk sold by dairy A^1, was rather variable and usually carried out only during the summer months to improve its keeping qualities. It is possible that these four patients had consumed it in the raw state and were infected as a result. The date of onset of illness—1 March 1954—of the transport worker suggested that infection had occurred before lambing had started in the Marsh, and so it is most improbable that the local sheep were responsible.

The infection of the other four patients is more difficult to explain as they were neither using raw milk nor were they obviously exposed to sheep. The four patients—the printer, the toolroom fitter, the social club manager and the hairdresser—were using pasteurized milk supplied by one or other of the two principal retail dairies (A^1 and B^1) in the area.

The type of milk supplied to all Romney Marsh patients at the time of their illness is given in general terms in Table 1. It will be seen that the proportion of raw to pasteurized milk users is similar in the Q-fever and control groups (i.e. 'other'). This finding differs from that in the urban area (see table 4 of the paper by Marmion & Harvey, 1956), in which a high proportion of the patients with Q fever had been using raw milk at the time of their illness.

In Chatteris–Witchford R.D. some fourteen (28%) of the fifty patients and twenty-six (24%) of the healthy adults in the survey had been using raw milk either at the time of illness or sampling. However, as already stated, there was little evidence of infection with *R. burneti* among them. The sixteen dairy herds in the area were not infected. In general, the group of raw-milk users in this area

forms a control for those using raw milk from infected herds either in the Marsh or in the two towns described in the accompanying report.

Table 5 shows (for the Romney Marsh) the distribution of the sporadic cases of Q fever and those in the play outbreak and also of the healthy adults with CF antibody to *R. burneti* arranged according to their dairy or other source of household milk.

It will be seen that the incidence not only of Q fever but also of antibody in healthy adults was approximately the same regardless of the source of milk supply. This finding differs from that in the urban area (see table 5 of the paper by Marmion & Harvey, 1956), in which the majority of patients with Q fever were found among the customers of five of the sixteen or seventeen retail dairies in the two towns.

(Unfortunately, the information on the milk supplies of the healthy adult volunteers was insufficient to calculate their serological experience by 'milk-exposure years' as in the investigation in the urban area. The figures given refer only to the milk supply of the volunteer at the time of blood sampling.)

As part of the milk sold by dairy A[1]—the T.T. and 'Channel Islands' supply—contained *R. burneti*, it was necessary to find out about the safety of the main pasteurized supply sold by this dairy. This did not come from the two infected herds of cattle owned by the dairyman, but from several other farms in the Marsh and elsewhere in Kent. It was pasteurized by the 'holder' method, and the results of phosphatase tests carried out on thirty-six occasions during the period 1949–53 indicated that pasteurization was adequate. Other tests showed that the plant was capable of inactivating a milk known to contain *R. burneti* when operated in a routine way.

THE OUTBREAK OF Q FEVER AMONG ACTORS IN THE PLAY

During the initial inquiries into the occurrence of Q fever in the Romney Marsh several persons recalled an illness which had affected some amateur actors taking part in a religious play held at one of the small villages in the Marsh. The play, based on the passion of Christ, was rehearsed and eventually performed for the first time in the village church at Easter, 1949. Ten of the thirty or so people connected with the play suffered from an illness which, from their histories and the opinions of the local medical practitioners, appeared to be clinically typical of Q fever. Specimens of blood were obtained in 1953 from nine of the ten persons who had been ill and also from eight symptomless members of the cast. Three of the nine sick players had CF antibody to *R. burneti* at serum titres of 1/40 or more; three had titres of 1/20, and three were negative when their sera were tested at dilutions of 1/5. Of the eight symptomless persons, six were negative and two had serum titres of 1/10. The finding that three of the sick players had antibody at 1/40 or more—a level which is rare in the healthy residents of the Marsh (see Table 2)—and the clinical histories of the patients, suggested that the outbreak had probably been Q fever. Presumably the antibody level had declined in some of the patients in the interval between the outbreak in 1949 and the serological sampling in 1953.

Table 5. *Romney Marsh. Incidence of cases of Q fever among persons suffering from pneumonia or undiagnosed fever arranged according to the retail dairy or other source from which they obtained their milk at the time of their illness. The incidence of antibody among healthy adults using the same suppliers (at the time of blood sampling) is also shown*

		Nature of the sample					
		Pneumonia/fever patients				Healthy adults	
Retail dairy or other supply	Type of milk	Q fever	Other	Total	Play outbreak cases	With CF antibody at or > 1/10	Total
Dairy A[1]	(*a*) Pasteurized (main supply)	4 (15)	23	27	7	10 (18)	56
	(*b*) T.T and 'Channel Islands'*	4 (19)	17	21	3	3	9
Dairy B[1]	Pasteurized only	2 (11)	17	19	1	3 (12)	24
Six other retail dairies or house cows	Pasteurized and raw	3 (11)	25	28	1	2 (11)	19
	Total	13 (14)	82	95	12†	18 (17)	108‡

* Shown to contain *R. burneti* and intermittently pasteurized (see text).
† 10 cases of Q fever; two having more than one milk supply.
‡ Sample of 106 persons; two having more than one milk supply.
Figures in parentheses show percentage of total.

The dates of onset of illness in the ten sick actors were closely grouped within a 7-day period, suggesting a short exposure to infection. Epidemiological inquiries so long after the event were hardly likely to yield any certain information on the occasion of infection. They did, however, establish that direct contact with sheep or other animals, or materials from them, e.g. untreated sheep fleece, was improbable either in the church itself or the neighbouring parish hut used by the actors for changing into their costumes. Indirect 'contact' with sheep was possible, however, in the sense that one shepherd with a role in the play came to rehearsals in his working clothes and accompanied by his sheep dog. Some members of the cast also went after rehearsals to a small inn nearby which was frequented by local shepherds. The illness of the wife of the publican at this inn, the only woman among the ten sick players, is perhaps of interest in this respect.

The occurrence of an outbreak of Q fever which was unlikely to have been due to the consumption of infected raw milk and which occurred among persons unconnected with agriculture and with no obvious direct exposure to sheep suggested the existence of an indirect method of dissemination of the rickettsiae from animals to those infected. The views of Clark and his colleagues (Clark, Romer, Holmes, Welsh, Lennette & Abinanti, 1951) on the spread of infection in the outbreak of Q fever in Colusa, North California, have already been outlined in the introduction to the paper by Marmion & Harvey (1956). In brief, they considered that some persons might have been infected by the inhalation of dust containing *R. burneti* which was carried into the town on the clothing of sheep farmers or other fomites.

Presumably also, sheep dogs, which may be contaminated at times with either sheep faeces or birth fluids, and which sometimes eat sheep placentas, might act as passive carriers of rickettsiae.

Apart from the outbreak such modes of transfer of infection might perhaps explain the infection of three persons among the sporadic cases of Q fever in the Marsh—the printer, the hairdresser and the grocer—all of whom had some contact with farmers during the course of their day's work.

In consequence an effort was made to demonstrate one stage of this transference of the rickettsiae from the sheep to places indoors. This was done by attempting to isolate *R. burneti* from eighty lots of floor sweepings collected during the 1954 lambing season from six small general shops and an inn in various widely separated parts of the Marsh. Hair clippings and floor sweepings were also collected from a hairdressing saloon used by agricultural workers. In addition to these samples twenty-four specimens of dust from the clothing of shepherds and other persons in contact with two known infected flocks of sheep were obtained with a suction device originally devised by Williams (1949) for the collection of haemolytic streptococci in floor dust. *R. burneti* was isolated from one specimen of dust collected from the clothing of a shepherd but the other samples proved to be negative.

GENERAL ECOLOGY OF *RICKETTSIA BURNETI* IN THE ROMNEY MARSH

The investigation in the Marsh has established that the sheep and cattle there and also the sheep tick, *Haemaphysalis punctata*, are infected with *R. burneti*. Transmission of infection to man apparently occurs in the main either as the result of exposure to lambing sheep or from the use of raw and infected cows' milk. There was no evidence of infection of man from *H. punctata*, although the period of its maximum prevalence coincides with that of the human cases of Q fever in the area.

The investigation was not primarily intended to find out how *R. burneti* spreads among the sheep or cattle, and no certain evidence can be offered on this score. Certain general observations may nevertheless be worth recording. On Romney Marsh lambing takes place in the open, sometimes in fields which are used year after year for this purpose. Infection might spread, presumably, from one sheep to another at lambing either by aerosol and the respiratory tract, or by the ingestion of pasture or water contaminated by the faeces and placentas of infected sheep (the sheep are usually, but not invariably, watered at various points on the network of drainage ditches that run along the edges of the fields throughout the Marsh), or by the agency of the sheep tick. According to local reports the number of ticks found on sheep and lambs has markedly diminished in recent years. Q-fever infection was observed in a flock which was maintained in circumstances which made it virtually tick-free. It would seem, therefore, that the tick, if an effective vector at all, would not represent the only means of spread of infection. In respect of the other possible methods of spread of infection it can only be given as an opinion that the method of spread—by aerosol and the respiratory tract—favoured by the North Californian workers could probably operate in the particular conditions of climate and animal husbandry in the Romney Marsh.

The finding of infected cattle in the Kentish Marsh, and not in the Fenland area of Chatteris–Witchford R.D. reflects a tendency, observed in other parts of Kent and East Anglia, for cattle to be more commonly infected in areas where there are numerous sheep. The evidence for the lack of infection in the cattle in the Chatteris–Witchford R.D. rests not only on the negative biological examination of herd milks from all the dairy herds but also on negative serological results on ninety-two cows in eleven of the sixteen herds in the area. In the Romney Marsh, on the other hand, the bulked milk of two of the seventeen dairy herds was found to contain *R. burneti* and eight of 139 cattle (mostly in the two herds with infected milk) had complement fixing at serum titres ranging from 1/10 to 1/80.

Reservoirs of infection other than cattle and sheep

Blanc & Bruneau (1953) have shown that the rabbits and ticks (*Hyalomma excavatum*) of an area near Casablanca are infected with *R. burneti*, and may serve to perpetuate the organism in the absence of domestic animals. In view of the finding that the Kentish sheep tick (*Haemaphysalis punctata*) was infected it was of interest to know if the numerous rabbits in the Marsh were also infected. Organs from 229 rabbits and thirty other assorted small animals were examined by guinea-pig inoculation with negative results.

Infection might perhaps spread from the sheep to carnivorous or other birds which scavange around them at lambing time and peck at the placenta. A demonstration of the possible spread of infection from domestic animals to birds is contained in the report of Syrucek, Raska, Lim & Havlik (1955), who found CF antibody in the sera of hens, pigeons and some wild birds taken near cattle infected with *R. burneti*. The organs of 166 wild birds of various species (trapped in the Romney Marsh) were examined, but *R. burneti* was not isolated. Our colleagues, Drs Fiset and Barber, have obtained some serological evidence of infection in chickens which were running on the same ground as sheep and will report their findings elsewhere (Fiset & Barber, 1956). Such findings do not necessarily imply, of course, that these birds play any part in the maintenance of *R. burneti* in the Romney Marsh.

DISCUSSION

Some discussion is required of the validity of the method used to detect the cases of Q fever in this investigation and in that described for the urban areas (Marmion & Harvey, 1956). The urban area was under more or less continuous observation during the period 1949–54, but the investigation in the rural areas did not begin until 1952. The intensive period of both investigations was 1952–4, and during that time patients were examined serologically fairly soon after their illness. The need to increase the numbers, both of Q fever cases and controls, necessitated, particularly in the rural areas, the examination of persons who had been ill between 1949 and 1951. The lapse of time between the illness of the latter on the one hand and the test of their blood on the other, introduces certain limitations and difficulties of interpretation. For example, it was obviously impossible to show a rising titre of CF antibody to *R. burneti* during the course of a particular clinical episode—a more satisfactory method of identifying such episodes as Q fever. Instead, we have identified them on the basis of probability arguing from the differences in frequency distribution of antibody at various serum titres in sick and healthy residents in the area. Further, although Q-fever antibody persists for a long time after infection, it is probable that the antibody level in some persons who had Q fever in 1949 would have declined below a serum titre of 1/40 by the time of sampling in 1952. An examination of fourteen cases of Q fever first diagnosed serologically in 1949 or 1950 showed that nine had CF antibody below this level by 1952 or 1953. (However, only three were completely negative at a serum dilution of 1/10.) The serological findings in the group of actors are presumably another example of the effect. In the Romney Marsh investigation in particular we may, therefore, have missed a few cases of Q fever which occurred during the years 1949–51. The inclusion among the controls of serologically negative persons, who may nevertheless have had Q fever, is not considered to affect the validity of the positive conclusions drawn from the comparison of Q fever and control groups, as the bias would be against the effects demonstrated. Deductions about the differing seasonal incidence of Q fever in the urban and rural areas should not be vitiated, as there is no reason to suppose that those who have Q fever in one season of the year will lose their antibody more readily than those ill at another.

The epidemiological patterns of human Q fever in the urban area and in the Romney Marsh present certain differences. In the urban area, where raw milk appears to have been the main vehicle of infection, cases of Q fever have been found (*a*) in most months of the year, (*b*) among persons exposed neither to farm animals nor to farm workers, and (*c*) equally among men and women.

In the Romney Marsh, on the other hand, where sheep appear to act as one source of infection for man, cases are (*a*) more frequent at the time of lambing and shearing; (*b*) occur among persons occupationally exposed to sheep; (*c*) are found among the users of pasteurized milk; and (*d*) occur more frequently in men than in women. It seems probable, however, that infection from raw milk was responsible for some of the cases of Q fever in this area.

In both the Romney Marsh and the two towns the newcomer to the area was more commonly attacked with Q fever than the old resident. It is common lore among the older shepherds in the Marsh that the new recruit to their ranks might expect to have the fever at some time during the first few seasons with his flock. This difference in susceptibility between residents of short and long standing may explain, perhaps, why relatively few cases of Q fever have been found among the local farming community who are often born and live most of their lives in the area.

In past investigations of Q fever in Great Britain much use has been made of the prevalence of low titres of complement-fixing antibody to *R. burneti* in the serum of blood donors (or other healthy adults) as an index of the presence or absence of Q-fever infection in an area. The results of the studies in the areas reported in this and the paper by Marmion & Harvey (1956) illustrate clearly the relation between the occurrence of clinical Q fever on the one hand and the proportion of donors, etc., with antibody on the other. Thus, in the Romney Marsh, the two towns and Chatteris–Witchford R.D., respectively, 13·7, 14·3 and 0% of pneumonias or fevers were probably Q fever, and the proportions of blood donors or other healthy adults with antibody were 15, 8 and 1·9%. The findings in the three areas also complement and confirm the conclusions drawn from a recent survey of healthy adults with Q-fever antibody undertaken in a larger area of Kent and East Anglia. In this survey (Marmion, Stoker, Walker & Carpenter, 1956) it was found that Q-fever antibody was commoner among those occupationally exposed to domestic animals in Kent but not among a similar group in East Anglia (cf. findings in Chatteris–Witchford). Persons using raw milk either in Kent or in East Anglia were found to have antibody to *R. burneti* more frequently than those who had used pasteurized milk (cf. findings in the urban area). Lastly, there was some correlation between the proportion of persons with Q-fever antibody and the number of sheep in various areas of Kent—a finding given added significance by the results of the investigation in the Romney Marsh.

SUMMARY

The epidemiology of Q fever in the residents of two rural areas, respectively, the Romney Marsh in Kent and Chatteris–Witchford rural districts in Cambridgeshire, has been studied.

In the Romney Marsh some 14% of persons who had suffered from pneumonia or undiagnosed fever probably had Q fever. No cases of Q fever were detected in Chatteris–Witchford R.D.

Two sources of infection—sheep and infected cows' milk—were found in the Romney Marsh, and the infection of some of the cases of Q fever could be attributed to them. There was also a group of cases who were probably not infected from milk or by direct exposure to sheep. They may, however, have been indirectly infected from sheep.

The absence of Q fever in the Chatteris–Witchford area is of interest in view of the use of raw milk by a substantial proportion of the inhabitants of this area and also because of their contact with cattle. Investigation, however, failed to reveal any infection of the cattle with *Rickettsia burneti*.

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